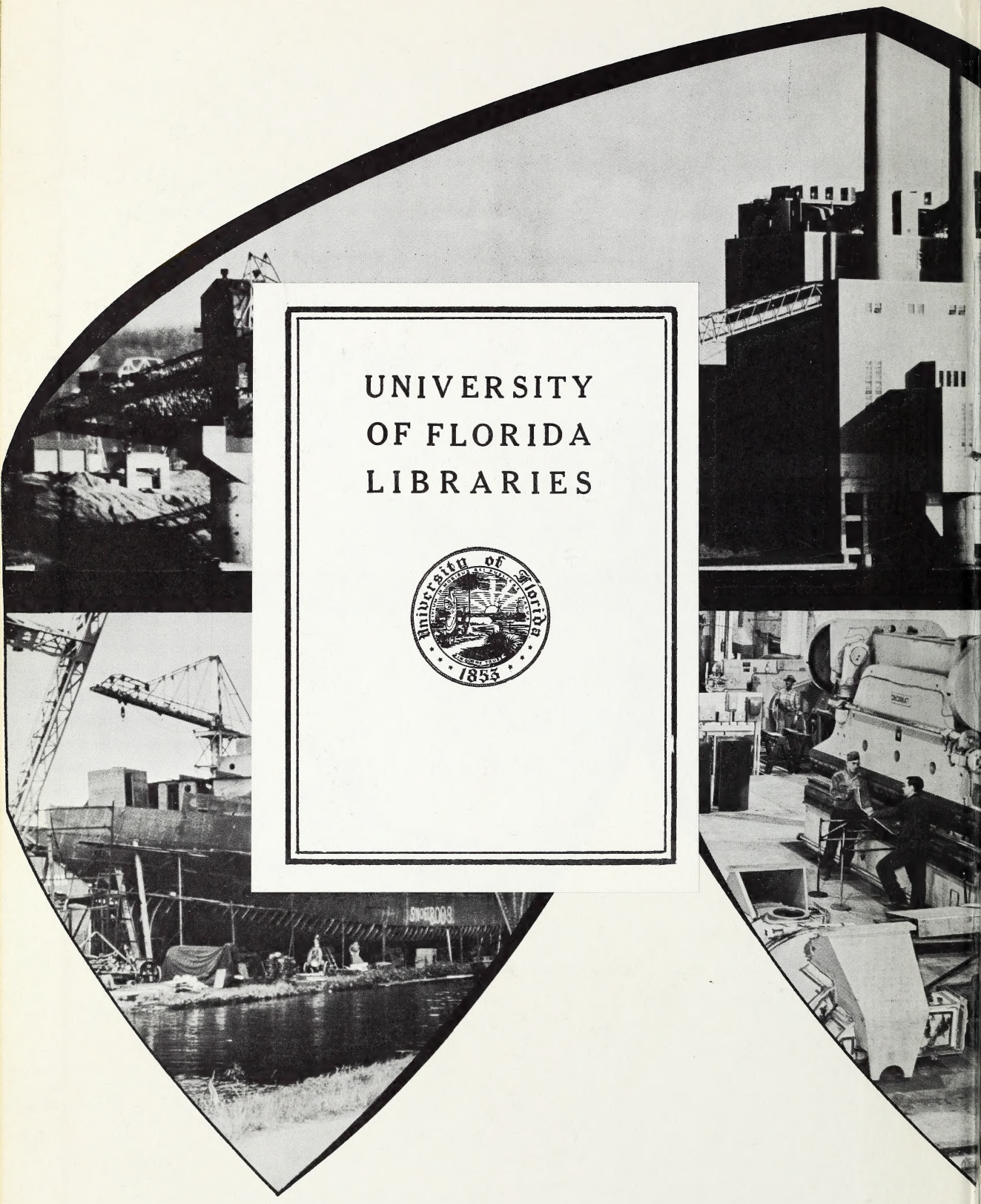
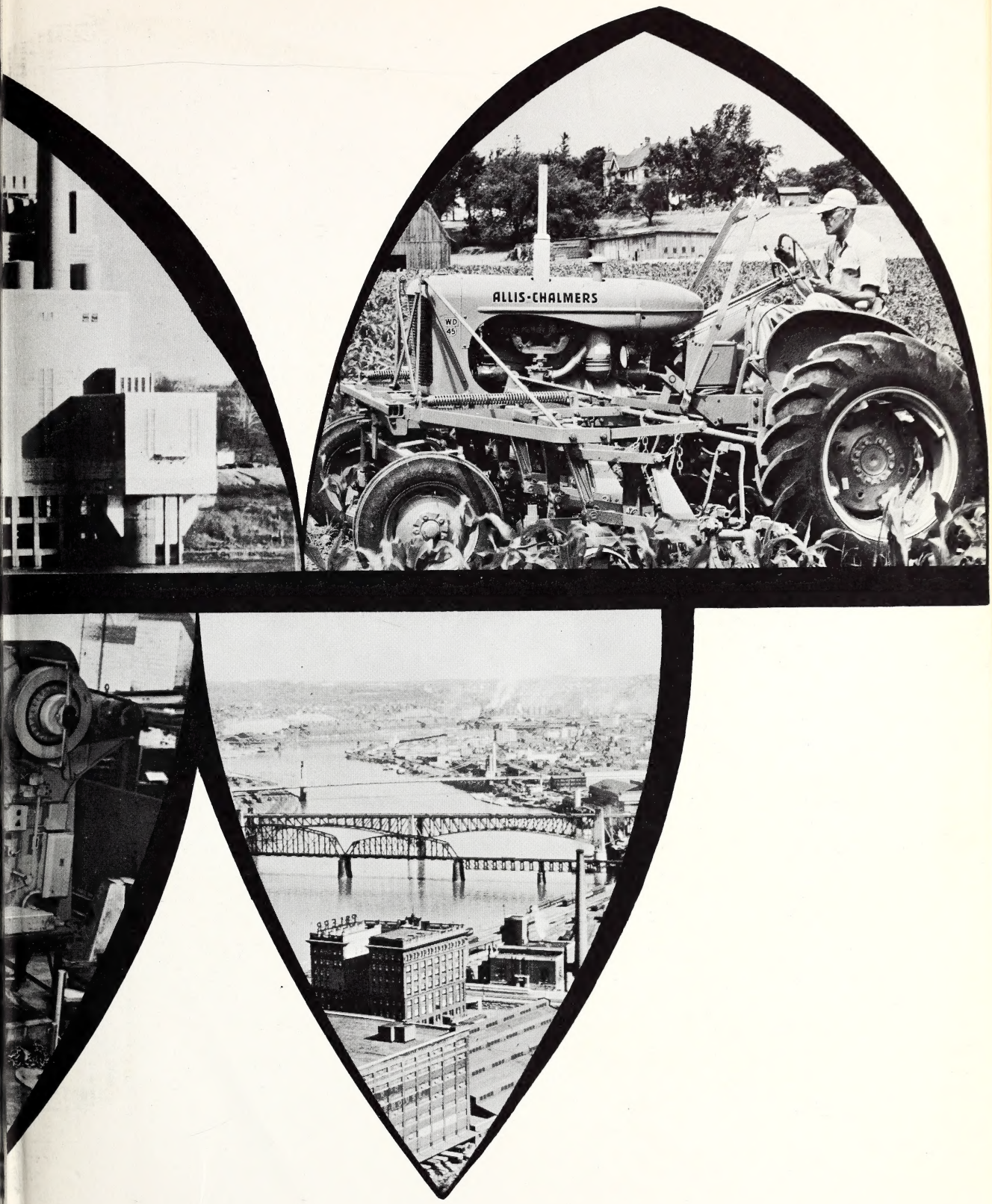
A GEOGRAPHY OF MANUFACTURING

E. WILLARD MILLER





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A GEOGRAPHY OF MANUFACTURING

E. WILLARD MILLER *The Pennsylvania State University*

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A GEOGRAPHY OF MANUFACTURING
by E. Willard Miller

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to RUBY

PREFACE

This book is intended to present a survey of the world's manufacturing. Most of what has been written about the geography of manufacturing consists mainly of articles and papers in numerous journals and reviews. This is, however, the first book in the field utilizing a world approach. It is written primarily as a response for those who need this information in a single source for use in this rapidly expanding field. The book does not have as its objective the transmission of new facts as much as the arrangement, into more significant patterns, of facts that are already known. An emphasis has been placed on the changing manufactural patterns and the factors that have influenced them, in the belief that the present industrial structure can best be understood in the light of evolutionary process.

The primary purpose of this volume is to serve the needs of students of geography and economics by describing and analyzing the complex areal patterns associated with manufacturing in the world. By this means it is hoped that greater knowledge of the scope of geography of manufacturing may be acquired, and further, that the factors of industrial localization will be better understood. It is the author's opinion that such a book should not employ a highly statistical approach.

The geography of manufacturing is treated both regionally and systematically in this book. An introductory chapter is devoted to the localization of manufacturing. The reader then becomes acquainted with manufacturing in the major world units. No attempt is made to discuss the manufacturing of every political unit. Rather, emphasis is placed on selected countries in order that the analysis can be more penetrating. The second part considers a geographical analysis of manufacturing of selected industries. Maps have been prepared in order to emphasize topics discussed in the text, to present geographic concepts, and to add information that could otherwise not be included.

I wish to make several specific acknowledgements. First, I wish to express my appreciation to John W. Alexander, University of Wisconsin, for his aid in preparing the introduction and chapter two. I am also greatly indebted to Alfred J. Wright, Ohio State University, for his critical reading of the entire text, and to Joseph Gregory for cartographic assistance. To Janice Wilson and Catherine McCloskey the author owes a special debt of gratitude for invaluable secretarial assistance and seemingly endless typing and retyping of the manuscript.

E. Willard Miller

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A GEOGRAPHY OF MANUFACTURING

LOCALIZATION OF MANUFACTURING

INTRODUCTION

The term "manufacturing" includes those activities by which man changes the form or nature of raw materials, converting them into more useful products. These transforming operations are conducted in factories, to which are brought raw materials from various source regions and from which go finished products to diverse market regions.

WHAT IS "GEOGRAPHY OF MANUFACTURING"?

What features of manufacturing are significant from the viewpoint of geography? The geographer is interested primarily in three aspects of manufacturing: its pattern of distribution, its relationships to other elements within its region of location, and its relationships to other regions (2).[1]

The relationships both to other regions and within the region of location are observable in terms of the association of manufacturing activities with certain other elements. Some of these are cultural elements resulting from man's activities—for example, markets, labor supply, transportation, subsidies, and regulations. Other elements are physical and are not the result of man's doing. These elements include raw materials, power resources, surface configurations, and climate.

Factories which characterize industrial regions may be interrelated: some may supply semifinished items to other factories; others may be branch plants; and still others may have a service relationship, such as a power plant, which supplies electrical energy to other factories. A relationship also exists between factories and nonfactory elements. For example, the factory may procure raw materials in the local region; a natural power source may be present; a portion of the factory's sales may be made locally; most of its labor probably resides there; and favorable transportation facilities may be present. On the other hand a factory affects other elements within its region. Thus, the relationships existing within the region of

[1] Numbers in parentheses refer to selected references at the end of each chapter.

location are "two-way" entities, in which certain elements affect manufacturing, and manufacturing in turn affects certain elements. The significance of manufacturing to its region of location is a question of constant concern to geographers.

The relationship between an industrial region and other regions is expressed in terms of market areas, transportation routes and services, freight rates, raw materials, and fuel supplies. The bonds of association may tie the industrial region either to other industrial regions or to nonmanufacturing regions, such as agricultural, mining, or forestry areas. The latter may be related because they constitute a market for the manufactured goods or because they are source regions sending raw materials to the factories.

Since the geographer is concerned with spatial relationships, his main emphasis in studying manufacturing is upon regions of industrial location and the factors by which manufacturing is related to other elements which also differ in spatial distribution, whether the elements occur within the immediate industrial region or in other regions—whether they supply factories or factories supply them.

GEOGRAPHICAL STUDIES OF MANUFACTURING

The geographer's study of manufacturing should produce works which contain certain characteristic facts and problems. These studies should describe manufacturing in such terms as pattern, amount, type of production, factories, and homes of workers. These items are basic characteristics differentiating regions of manufacturing. Facts also are needed about the relationships which tie manufacturing to other elements in its region of location. What percentage of the region's labor force is employed by manufacturing? How much labor resides within the area? Is the labor force stable, or does it have characteristics which might cause manufacturing to seek more favorable areas? How significant is the region's market to the region's manufacturing? Does the region supply any raw materials? What is the transportation situation? What local forces operate as subsidies to manufacturing?

Relationships between a manufacturing region and other regions likewise are described by facts relating to markets, raw materials, power, labor, and transportation. Facts on cost are significant because manufacturing is an economic activity which stops when costs become too high. Indeed, the basic reason for spatial differentiation in the location of manufacturing within advanced countries is the spatial differentiation in costs of manufactural operations. Moreover, facts on costs enable the drawing of comparisons between different regions of manufacturing.

Facts on trends are necessary for understanding how manufacturing began in a region, how it has progressed, and what it can be expected to do in the future. Such facts also help distinguish regions where industry is expanding from regions where it is not.

But such factual information is not enough. To say that a community has so much iron and steel industry, which feeds upon coal from one source, iron ore from another, limestone from still another, and local water—or that it sells its product in certain market regions—is to give only part of the picture. What are the problems which that industry faces in that region? To what degree does it compete successfully with other steel regions? In what respects is it handicapped by physical features, such as terrain and water routes? To what extent is it handicapped by cultural features—public attitudes, transportation services, or available labor?

A second type of problem involves those factors created by the industry's activities. What problems in that region exist because the steel industry is located there? What does manufacturing do to that community? An understanding of these problems may enable one to conclude that some other region would be more desirable for the industry. Application of such geographical knowledge is fundamental for all plans for location of branch factories or for new locations of established operations. In fact, it has been basic to the regional shift of entire industries—such as the decision of cotton textile producers to deemphasize operations in New England in favor of expansion in the Piedmont. Business executives, research men, and specialists in the field can make certain proposals for the future of

manufacturing if they apply geographic knowledge to the problem of industrial location.

Geographic studies incorporating facts and problems of manufacturing may be of several types. The *industrial* study focuses upon a single industry. It may be a broad industry such as foods, leather, or wood products. It may be a specialized industry such as cane sugar refining, women's gloves, or excelsior. Whatever the scope of the industry, the attention is directed toward the several regions in which it is located and the geographical relationships that involve it.

The *regional* study focuses upon a single region of manufacturing. It may be a broad region such as a nation or a state; it may be more restricted, such as a county, a metropolitan area or a zone within a city. Whatever the extent, attention is directed toward the pattern of manufacturing in the region, the several industries which compose the industrial complex, and associations relating to it.

A *location factor* study is centered on a particular relationship by which manufacturing is tied to its local region or a distant region. The relationship may be with raw materials, with markets, with labor, with freight rates, or with many other factors. The purpose is to show how a particular factor operates in the location and development of manufacturing.

A geographical study of an *individual factory* explains the relationships between that factory and two types of regions: (a) those which affect the factory, and (b) those which the factory affects. The same actual region may be represented in both instances. The first type supplies the factory with such items as a demand for its product, raw materials, power, labor, empty buildings, subsidies, or other necessities. The second type results from that factory's existence. The former region may be the local territory in close proximity to the industrial plant, or it may include territories at a considerable distance. The second region rarely exceeds the local territory because it is in the home community that such effects as smoke nuisance, traffic and parking problems, workers' housing, and workers' demands for trade, schools, and other services all give evidence of what that factory is doing to the community.

A study of *potential manufacturing areas* is a predictive effort to discover regions which would be suitable for the location of manufacturing (or for additional manufacturing if some already exists). It postulates the character of possible relationships.

In each of the foregoing types of studies, the relationships between manufacturing and transportation are of fundamental importance. Localization of manufacturing in advantageous areas is possible only because of the movement of goods and people. In fact, transportation is the thread which binds factories to regions and industrial regions to other regions. It is by way of this thread that most geographic relationships can be traced. Regardless of the type of study by which the geographer analyzes manufacturing, the characteristic contents will be present: facts dealing with patterns and spatial relationships, and problems relating to them.

FACTORS OF INDUSTRIAL LOCALIZATION

Manufacturing is localized as a result of a complex of many factors (76). In analyzing the various reasons why manufacturing is located at a particular place or why it has remained at that location, a combination of a number of favorable factors is usually found. However, seldom (if ever) does a manufacturer find that an area possesses only favorable factors. The problem of establishing an industry resolves itself in finding a site with a sufficient number of favorable factors to counterbalance the disadvantageous conditions. For the successful operation of any manufacturing endeavor, seven primary components must be considered: raw materials, power, fuel, markets, labor, transportation, and capital. Other factors of location that influence particular types of manufacturing include climatic conditions, water supply, waste disposal, tax structures, and governmental policies.

Raw materials. The availability of raw materials is frequently a major locational factor. It is particularly important in the initial stages of manufacturing (57). For example, the early shoe industry of Massachusetts was concentrated there because of the presence of local leather supplies. The early woolen mills were also located in New England, where wool from

the local sheep industry was available. The development of Cincinnati as an early soap center was primarily due to the availability of fats from the local stockyards. However, the influence of raw materials as a locative factor has declined in the twentieth century due to a number of reasons. The development of a major network of transportation systems has facilitated the movement of raw materials. Further, as manufacturing becomes more complex there is relatively less processing of basic raw materials by individual manufacturers. At the present time in the United States only one out of five manufacturers directly processes basic raw materials. Most industrial firms purchase partially manufactured commodities from widely distributed sources.

Technological improvements resulting in a more intensive utilization of raw materials has also lessened their importance in localizing manufacturing. Moreover, as labor and market exert greater locational influences, raw material orientation diminishes. Finally, the general decentralization of manufacturing combined with competitive sales equalization practices have encouraged manufacturers to increase the distance between the producing plant and the raw material source.

Nevertheless, the need for being near raw materials is still imperative for many industries. In general, an industry will tend to locate at that point where it has the lowest aggregate transportation cost in the assemblage of raw materials and the shipping of its finished product. Thus, raw materials that lose considerable weight or bulk are still being processed at their point of origin. Excellent examples of this type of industry are the drying of fruits and the dehydration or evaporation of milk. Other typical industries of this group are the extractive industries involving the smelting or concentrating of low-grade ores, such as copper smelting. The sawing of lumber at the timber source is still another example of reducing the raw timber at its source by the removal of slabs, the loss in sawdust, and the culling of knotty, splintered and decayed boards. This initial processing reduces the bulk from 25 to 40 per cent, resulting in substantial savings in freight costs. The naval stores plants, comprising nearly 1,000 small factories, blanket southeastern United States, where the trees are tapped. Here again the process entails a considerable reduction in bulk.

A second group of raw material-oriented industries are those in which perishable raw materials are converted into nonperishable—or at least less perishable—products. In these industries the relative weight of materials and products is about equal, but procurement costs are considerably greater than distribution costs. Sugar beets are refined near the field; vegetables are canned near the field; butter and cheese are produced near the dairies which contribute the milk used; salmon canneries are located near the salmon fisheries, and berries are made into preserves near the producing tracts.

When the raw material is not perishable and there is not a substantial loss in processing, the relative transportational rates between the raw material and the finished article will determine the best location for the plant. In general, freight rates increase with value added in manufacture. Thus, raw materials normally receive lower freight rates than finished products. However, when the manufactured goods are of relatively low value and at the same time enjoy transportational advantages, the freight rates are about the same as on raw materials. Consequently, the influence of a market is minimized. For example, the cost of shipping raw cotton and some finished goods is about equal, so that mills have a choice of either a raw material or market location.

When the market or raw material factor is dominant in localizing an industry it is usually situated at one or the other place and not at an intermediate site. Generally, intermediate points between raw materials and market are costly centers of manufacturing. This is because increased transportation costs for freight rates are normally composed of terminal costs plus a line-haul cost. As the distance between terminals increases, the terminal charges become relatively lower. When the average hauls are shortened by intermediate terminals, both the inbound and outbound rates must continue to support terminal charges. Accordingly, the total freight cost at an intermediate location may be higher than would result from location at either the raw material source or the market.

In selected industries the disadvantages of an intermediate location are overcome by the establishment of in-transit privileges. Under this arrangement the through rate from origin to final destination is instituted. Such industries as the milling of grains, simple fabrication, and compressing of cotton have had this arrangement developed for their benefit.

Power. Historically the site of power resources was one of the major factors in determining the location of manufacturing. Until the Industrial Revolution, power in industry was primarily supplied by human and animal muscle. With mechanization, power was required in greater amounts. For several centuries power was primarily obtained directly from running water. Until near the end of the nineteenth century, when water power could be converted to electrical energy and transported great distances, almost all mechanized industries were forced to be located on streams that could be harnessed.

In southern New England—the original area of concentration of American manufacturing—the orientation of industries to water-power sites is still evident, for much of the older industry is strung along the small streams. In the Middle Atlantic and Southeast states much of the early industry was attracted to cities situated along the Fall Line—that line where the river left the higher Piedmont Upland and entered the lower Coastal Plain. At these points, where rapids and falls exist, water power was available to operate the factories and the small ocean-going vessels could navigate to wharves immediately below the factory site. This attributed to the growth of such Fall Line cities as Trenton, Philadelphia, Wilmington, Baltimore, Richmond, Raleigh, Columbia, Augusta, Macon, and Columbus. The localizing influence of water power is also evident in the pattern of the textile industry in Lancashire, England, with the industry situated in the foothills of the Pennine Range where water power was most readily available.

With the substitution of coal for running water as the prime source of power, manufacturing no longer had to be situated at the power source. For most industries, an adequate supply of coal could be secured at any place served by railroads or water routes. Still later, the mobility of power was further increased by the development of electrical transmission. Electric power can now be transported 300 to 400 miles from its point of origin.

Nevertheless, cost is involved in the transportation of coal and electricity. Consequently, for those industries using huge quantities of power—where power input costs are large in comparison with other manufacturing costs such as raw materials, labor, or transportation —nearness to a source of power is essential. This is illustrated effectively by the electrometallurgical and electrochemical industries. Niagara Falls was the first major hydroelectric power center in the United States. Today this area is the leading electrochemical center in eastern United States. The enormous hydroelectrical potentialities of northwestern United States have attracted industries in the electrometallurgical group. The Tacoma, Washington copper refinery has long drawn copper from not only western United States but also from foreign areas such as Chile. During World War II the aluminum industry located plants in both Oregon and Washington to take advantage of available hydroelectric power.

Fuel. Fuel, primarily coal, petroleum and natural gas, is the common denominator applied to manufacturing. It must be remembered that fuels, as a source of thermal energy, can frequently be substituted one for another and are thus highly competitive.

As a locational factor in manufacturing, fuels vary greatly in importance from industry to industry. In those industries where large quantities of fuel are used as a basic raw material, the manufacturing processes are frequently oriented to the fuel source. Typical examples are the manufacture of coke and coke by-products from bituminous coal in the Pittsburgh District. The gravitation of the petrochemical industry to such Gulf Coast cities as Houston, Galveston, Texas City, Beaumont and Lake Charles reflects the availability of natural gas and crude oil supplies.

In many of the heavy industries, fuel, when considered along with assembly costs of raw materials and freight rates to markets, becomes an important consideration in locating plants. Processes with large fuel requirements always involve a high proportion of weight loss and are likely to be localized near fuel

sources, since the weight of the fuel does not enter into the resulting product. Most of the industries using large amounts of fuel are found in the initial stages of processing. Metallurgy and the making of cement, glass, calcium carbide and synthetic nitrates are examples. Orientation to coal sources has been a major factor in the development of many of the iron and steel regions of the world. The heavy metallurgical centers of Pittsburgh-Cleveland-Wheeling; Birmingham, Alabama; the Midlands and East Pennine areas of England; the Scottish Lowlands; the Ruhr; Sambre-Meuse Lowland; Upper Silesia; and the Donets and Kuznetsk basins of the Soviet Union are oriented to coal areas. However, not all metallurgical centers are situated on coal fields. Changes in pricing policies, freight rates and shifting markets are reducing the influence of a fuel supply on the location of blast furnaces.

The declining influence of the fuel source as a location factor is also reflected in the glass industry. Originally, most glass plants were situated close to fuel sources—first charcoal and later natural gas (8). In the manufacture of glass containers, fuel represents as much as 33 per cent of the total production cost. However, modern glass plants are being established closer to market areas, indicating a lessening influence of the locational attraction of cheap natural gas supplies. It is cheaper to transport the natural gas to the glass market area than it is to transport a fragile glass product.

Market. The market as a locative factor in manufacturing is increasing in importance (28). Under normal conditions plants are established where a transportational advantage insures access to a substantial local market, and where a good competitive position is maintained to serve important adjoining market areas. An orientation to market may thus be based on a weight or bulk gain in the process of manufacturing or on higher freight costs of the finished products than on raw materials.

Many types of manufacturing involve the incorporation of large quantities of some ubiquitous material like water. As a result the weight of the product often exceeds total weight of the imported raw materials. A ubiquitous material is one that is obtainable everywhere at essentially equal costs so that it has no transfer costs. It does add to the weight of such products as beverages and inks and gives the manufacturer an inducement to locate as near the market as possible in order to reduce distribution costs (34).

Factories which produce perishable products are usually market oriented. Perishable products, including bakery goods, ice cream, ice, and newspapers, must be marketed quickly or their value declines rapidly. However, improved techniques of transportation have a tendency to weaken the market orientation of these types of manufacturing.

In the manufacturing process, when the bulk of the product is increased a market location is desired. In this category belong such items as machinery, pianos, barrels, furniture and automobiles. For example, an automobile when assembled occupies five to six times the space of its parts. As a result, parts factories are not necessarily market oriented, while the final assembly into a bulky machine tends to be done in assembly plants within a market area.

A market location is also encouraged, for it is commonly cheaper to transport raw materials than it is to transport the finished products. It is thus more economical to locate the processing plant near the consumer than to the source of the raw material. The reasons for this situation reflect a fundamental concept in manufacturing. As products pass through successive steps of production after the initial bulk-reducing, purifying, or preserving operations and gradually assume the form to be delivered to the consumer, they become progressively more fragile, more cumbersome to pack and handle, more valuable in relation to weight, and differentiated into more types and sizes (34).

A considerable portion of manufacturing is not oriented toward a local market, but is concentrated in areas having maximum accessibility to regional or national markets. This type of location reflects a position where there is a large national population possessing a high purchasing power. In the modern world the per capita income is usually higher in manufacturing areas than in areas where income is derived from other sources. More people are required to carry on manufacturing than for

other kinds of production and consequently manufacturing regions are areas of high population density.

The proximity of factory to market also has other advantages. When a manufacturer needs to have intimate knowledge of his customer's needs and of changes that occur, nearness of producer and consumer is desired. Examples of this are the rapidly changing technological devices, such as electrical machinery. This proximity also applies to the apparel industry, where style changes are frequent and the market whimsical in its demands.

The market is also an important localizing factor in basic industries. The production of iron and steel, even though a raw material-processing industry, is frequently oriented to a market which requires primary iron and steel. The Pittsburgh iron and steel region, which is located near coking coal, is a superb example of being situated in a favorable market location. It is centrally located in the huge market area of the American Manufacturing Belt. Within the twentieth century the new iron and steel regions have been situated near markets, as is demonstrated by the growth of Gary, Indiana near Chicago, the establishment of the Fontana plant east of Los Angeles, and the recent construction of the Fairless Steel Works near Levittown, Pennsylvania on the Delaware River.

In contrast to these successful market oriented locations, the iron and steel industry has remained small in areas where the market was limited, even though other factors were favorable. For example, Birmingham, Alabama, which possesses coal, iron ore and limestone locally, has remained a relatively small center of production. The inadequate southern market has been a major limiting factor. Likewise, Duluth, located close to the iron ore of the upper Great Lakes, has remained a small iron and steel center because of lack of a local or regional market.

Labor. The cost, availability, stability, and productivity of labor are vital factors in every manufacturing enterprise. If these labor factors are not favorable the growth and future of any industrial area are jeopardized. Labor requirements for industries are not uniform. Certain industries require a large number of skilled workers; other industries require a large number of unskilled workers; and still others require varying amounts of each.

When considering characteristics of labor, cost factors are among the vital items. It must be recognized that wide variations in wages exist between regions, between large cities and smaller communities, and even between neighboring cities. In general the lowest wage scales in the United States exist in the Southeast. The highest wages are found most often in the Pacific coastal cities. The wage scale is affected by many factors, including the number of male, female, white and non-white workers employed, the skill of the workers, the type of industries within an area, and the climate. It has sometimes been felt in recent years that the differential in wages is disappearing, primarily because of the influence of unions. This appears to be an incorrect assumption. The geographic spread in wage rates is as great at present as in any previous period.

Differences by states are illustrated by data on average weekly hours worked and average hourly earnings of production workers for 1952 and 1960 (Table A.1).

TABLE A.1

	Average weekly hours worked		*Average hourly earnings*	
	1952	1960	1952	1960
California	41.3	39.8	$1.79	$2.62
Oregon	38.9	38.1	1.97	2.55
Illinois	41.4	40.0	1.67	2.45
New York	39.0	38.8	1.65	2.31
Pennsylvania	40.0	38.9	1.61	2.31
Massachusetts	39.1	39.2	1.53	2.09
North Carolina	38.3	39.7	1.17	1.54
Tennessee	40.0	39.8	1.29	1.84

Source: Statistical Abstract of the United States, U. S. Department of Commerce, Washington, D. C.

Wage differentials have tended to persist because of a variety of circumstances. It was once felt that when a rural area industralized, wages would rise rapidly. This situation has occurred in southern California, where competition for labor has been high. In contrast, however, North Carolina's low average wage persists where there is little competition among industries, although the industrial wage earners in the textile industries number more than 240,000. In general, wage differentials are least in skilled occupations; but even here significant differentials exist. For example, in a survey by the U.S. Bureau of Labor Statistics in 1959-60 it was found that Class A welders in machine shops earned $1.83 per hour in Dallas, $2.00 in Boston, $2.26 in Pittsburgh, and $2.43 in Newark-Jersey City.

The wage level in large metropolitan centers is generally higher than in smaller communities. Hourly wage rates on July 1, 1961 for printing trade workers in commercial and newspaper establishments in various city-size groups, according to the Department of Labor, were as follows:

	Average hourly scale	
Cities with population of:	*Book and job*	*Newspapers*
1,000,000 and over	$2.66	$3.17
500,000 to 1,000,000	2.52	3.05
250,000 to 500,000	2.48	3.03
100,000 to 250,000	2.78	2.84
40,000 to 100,000	2.64	2.57

The basic reason for these differentials lies in the expenditure standards of individuals in the different size cities. In the larger cities, although individual commodities will be priced the same as in the smaller cities, there is a wider choice in how dollars are spent, resulting in increasing inducements to spend. It is much more difficult to be thrifty in a large city. In the smaller city, pleasures and luxuries are simpler, less expensive and probably less frequent. Living in metropolitan areas entails expensive housing and expensive and time-consuming commuting. As a consequence the cost of living is usually higher in areas of concentrated economic activity possessing a dense nonagricultural population. Thus, it is evident that labor costs are significantly raised as a result of both intangible and tangible expense factors.

When labor costs are an important proportion of total delivered-to-customer costs of a given product, the selection of a particular labor cost area is of the utmost importance. There are at least three kinds of locations that have conditions conducive to low labor costs. These are places where population pressures are great, in that expansion of employment opportunities has lagged behind the growth of the labor force. As a result people are willing to work for lower real incomes than elsewhere. In the late nineteenth century the Piedmont area of the South was able to attract the textile industry from New England largely because of its excess labor supply, unable to find other economic opportunities and willing to work for low wages. This labor situation also applies to economically depressed areas where the economy is in transition. An example of this condition exists in the anthracite region of Pennsylvania, where there is an excess labor supply due to the decline of mining. The most rapidly developing industries in this area are those attracted by low-cost labor.

There are also places where the nature of local employment and the size and structure of the local labor market develop an unusually productive or adaptable labor force, resulting in higher productivity per man hour. This type of labor force develops in the older industrial regions where skills have been acquired for generations. The advantages of this situation are based largely on the efficiency of the particular local labor force, which is directly related to the economies resulting from specialization and large-scale organization of a firm.

Finally, there are those areas attractive from the viewpoint of having low living costs or such amenities as a pleasant environment. If such places are sufficiently attractive, people are willing to work there for lower wages than elsewhere. This situation prevails primarily in the warmer areas of the United States, notably Florida and certain parts of the Southwest.

Besides labor costs, the availability and stability of different types of labor are important localizing factors. If an industry uses a wide variety of types of labor it is best able to satisfy its needs by locating in a metropolitan area. This is particularly the situation with unskilled labor. Reservoirs of this kind of labor

are normally largest in urban centers. Consequently, many factories are established at centers which are in the midst of a labor supply. The availability of labor depends to a considerable degree on its mobility. In the modern period unskilled labor is exceptionally mobile. The unskilled worker is rarely tied to a particular locality by either property holdings or strong social ties. The automobile and good roads have made it possible for labor to travel quickly to areas of greater economic opportunity. This is reflected in the recent mass movement of workers from the Southern Appalachians to the northern cities, such as Chicago, Detroit, and Cleveland. At times these migratory workers appear in unwanted numbers upon the merest suggestion of a factory job. As a result of the mobility of unskilled workers, the influence of labor as a locative factor in manufacturing is lessened.

In contrast, skilled labor behaves in an entirely different manner and its influence as a locative factor is much greater. Once a skilled labor group develops in an area it constitutes a geographical entity of a relatively permanent character. Such concentration of skilled labor is a definite factor affecting the location of certain types of industrial enterprise. For example, Connecticut's Naugatuck Valley makes about half the nation's brass. Similarly, New Britain is noted for its hardware, the Connecticut Valley cities for firearms, and the Blackstone Valley for fine cloth. Skilled labor becomes significant in locating industry in those cases where labor costs are a major percentage of the total cost of manufacturing.

Labor stability is of great significance to the successful pursuit of manufacturing. Unfortunate labor relations have forced plants to migrate from a region. The causes of difficulty between management and labor are changing. As unions become established and stronger, relatively few work stoppages now occur over the fundamental question of whether a union organization should exist. Wage increase demands, amount of fringe benefits, and jurisdictional disputes are still important items of conflict. There can be no assurance that a community will be free from future labor disputes. However, a good indication of the future is revealed by the history of labor relations in a region. A community which has long experienced industrial peace is a much better prospect for good labor relations than one in which there has been a lengthy history of industrial strife. The number of labor strikes and their duration are barometers of management-employee relations.

Labor instability may also be evidenced in ways other than a strike. An adamant attitude on the part of employees, employers, and unions in the final settlement of a problem can stifle industrial growth. Other facets of labor trouble are manifested in excessive absenteeism, labor turnover, tardiness, and a disrespect for work rules and regulations. In a well-run plant an absentee rate of three per cent is to be expected. A labor turnover is even a greater indicator of unrest, particularly in industries where training costs for developing worker skills are high.

Transportation. The location of manufacturing is greatly influenced by availability of transportation facilities (22). The location of industry in any given area may depend directly on the type of transportation present. In the early stages of industrialization, when raw materials were usually obtained from the immediate locality and the finished goods marketed within a restricted region, transportation played a lesser role in localizing industry. As a result, manufacturing was highly decentralized. As manufacturing grew in size, areal specialization increased. Small areas thus produced a large proportion of a product consumed by the nation, making it necessary to develop adequate transportation to reach distant markets. The more efficient, cheap and dependable these means of transportation become, the greater is the tendency for manufacturing to concentrate in areas providing an advantage in this respect.

The influence of transportation as a localizing factor is evident in every modern manufacturing region (4). Within the United States every major transportation center is also a significant manufacturing center. The growth of a major manufacturing zone along the New York Central Railroad from New York to Chicago in such cities as Schenectady, Syracuse, Rochester, Buffalo, Cleveland, and Toledo illustrates the importance of transportation. This route, following the lowlands through New York State and skirting south of the

Great Lakes, reflects the importance of a lowland route. All transportation routes seek the lowest grades and thus, as far as possible, circumvent natural barriers.

Since freight rates are part of the delivered-to-customer cost, the relative cost of the type of transportation in most instances will determine the type of carrier utilized. Expedited services such as air express, air cargo, and railway express are relatively expensive, and the urgency of shipment must be balanced against the price of the service. Only products of high value which must be marketed quickly can justify this type of transportation. For example, a dress manufacturer in New York may want to place a particular style of garment on the market in several cities simultaneously. Air transportation will serve his needs best.

The vast majority of high or medium grade traffic is routed via rail or truck, with the specific choice being determined by length of haul, relative rates, and convenience (39). In recent years trucks have competed most favorably with the railroads. In order to meet present day needs, specialized transport equipment has been developed for both trucks and railroads, to be used for bulk commodities, liquids, refrigerated products and other commodities requiring special handling.

Industries based on the consumption of large quantities of low-value raw materials are oriented whenever possible to water route haulage. Transportation costs on water routes are cheaper than on land routes primarily because of two factors. The water routes are provided by nature and when improvements are needed these are normally paid for by the government rather than by a private company. The classic example of the influence of water routes is the movement of iron ore for smelting from the upper Great Lakes to the lower Great Lakes ports. Annually more than 80 million tons of iron ore are moved by water transportation. The recently developed iron and steel industry at Morrisville, Pennsylvania is not only concentrated in a large market area but fronts on the Delaware River, in order that most of the raw materials can be assembled by water transportation. Another example of water transportation influencing the location of industry is found on the Gulf Coast. The oil from the interior of Texas and Louisiana is moved to the Gulf Coast cities, where much of it is refined before it continues its journey by tanker to the East Coast markets. A great petroleum refining and petrochemical industry has developed at the break-in-transportation between land and water routes.

Capital. Historically the availability of capital within a given region was a major factor in the growth of manufacturing. At the beginning of the Industrial Revolution in Europe and America, local capital was necessary for industrial progress. This situation still prevails in the few isolated areas of the world where a local economy persists. Under such conditions, the accumulation of capital for the initiation of manufacturing occurs only in restricted localities. Capital is thus restricted to a local use, and in a way tends to locate industries within the area of available capital.

The above situation applies only to early stages of industrial development when capital does not enter the area from outside. The growth of corporate finance has greatly reduced the importance of local capital. As economic maturity progresses, capital becomes mobile. The important manufacturing districts of the world in modern times are located with little regard to a source of money for their development. Capital is readily available to all parts of the world where political security and financial returns are reasonably guaranteed. As a consequence, capital as a locative factor may be disregarded in the industrial nations of the world.

Climate. The climate of a region has a direct influence on costs of industrial output. The warmer regions of the United States have a comparative cost advantage over colder areas. For example, a southern industrial worker, in order to have the same level of living as a worker in New England, can have a salary 10 to 20 per cent lower. This is because heavy winter clothing is unnecessary, heating bills are smaller, and many foods produced locally are obtained at lower costs.

Besides the general influence of climate, its influence is direct in a number of industries. In manufacturing where large open buildings are required, such as aircraft production, a

warm climate is desired in order to decrease the cost of heating large buildings. The availability of sunshine is also of vital importance to some industries. The drying of fruit depends upon a continuously sunny, dry environment. Likewise, the testing of aircraft is much more easily done in areas where there is a maximum amount of sunshine during the year.

The climate of an area may also be of considerable importance in the selection of a particular site of a plant. The velocity and direction of prevailing winds may affect the ventilating problems of large plants. This is particularly important if the plant generates fumes, heat, or noxious odors.

It is now generally recognized that climate affects efficiency and general working conditions. The ideal industrial environment is found in those areas where the climatic changes are modest from season to season. These changes are stimulating. As a result, a worker can accomplish more in a given time and with a greater degree of efficiency. However, in areas where changes are extreme, respiratory diseases are increased and loss of work results in higher cost production.

Water. Water as a localizing factor has become of increasing importance in recent years. As a result of new technology in many industries the demands for water have increased greatly. Consequently, the problem of securing usable water at reasonable rates is now a major one. An adequate supply of water is a necessity in choosing a site for such industries as iron and steel, pulp and paper, food and chemical processing, and wool scouring.

In considering industrial localization, both the quantity and quality of a water supply are of importance. The two major sources are surface water from streams and lakes and ground water from springs and wells. Of these sources the most reliable supply and the most consistent in composition is from lakes. Lake waters are usually clear, soft, and high in oxygen because there has been adequate time for impurities to settle out during storage. The value of a stream for industrial purposes depends on such factors as maximum flow, seasonal fluctuation, tidal influences, temperature, mineral content, and impurities.

With expanding urbanization it is increasingly difficult to find water free of impurities or minerals. Hard water must normally be treated, for the corrosion and scale resulting from its use can create problems in steam boilers, circulating systems, diesel engines, hot water pipes and pumps, and industrial processes. The costs for replacement and disruption in operations can be most serious in the functioning of a plant.

The disposal of waste materials at the plant is becoming a major problem (50). Almost all states now require that waste be removed from industrial water before it can be disposed of in streams or lakes. Because industrial wastes can be harmful, a stream can carry away only a given amount. Therefore, such factors as rate of flow of the stream and the type of treatment required must be considered. Because woolen and worsted mills, chemical industries, dye plants, and others add more impurities to water than many other industries they are normally subject to unusually stringent control. Other industries having normal waste problems can usually use community sewage disposal plants satisfactorily.

The quantity of water available for industrial purposes is also becoming a problem in many areas. If a shortage of water develops, the normal order of priority becomes domestic and sanitary uses first, agriculture second, and industry third. As a consequence, industries requiring huge quantities of water hesitate to depend on available public supplies. The quantity of water from underground sources depends on the porosity and permeability of the rocks in the area. As water is removed from the aquifer the pressure is decreased and the yield is consequently lowered. In some urbanized areas, such as Los Angeles and a number of East Coast cities, the decline of yield from wells has been of grave concern to industry. In a number of coastal cities the water table has been lowered so drastically that the fresh water supplies have been contaminated by sea water.

Besides direct industrial uses, water is also used for cooling purposes. When this is the situation the climate of the area may become an important localizing factor. Surface water will assume the temperature of the air. Thus, in areas which have freezing temperatures open water pipes must be protected. If, how-

ever, the water comes from underground sources, another problem may be experienced. In general ground water from less than a 30-foot depth is about the same temperature as the mean annual temperature of the area. At a depth of 60 feet the supply of water is usually two to three degrees warmer than the mean air temperature, and increases at about one degree for each additional 64 feet of depth. To illustrate, a plant which requires a maximum temperature of 60 degrees in its cooling operations could not locate in southern California without erection of cooling towers. In the Los Angeles area, well water averages from 70 to 74 degrees in temperature.

Taxes. The influence of a tax structure on the localization of manufacturing in a given area is difficult to evaluate. The growing importance of federal taxes tempers the impact of local and state taxes. It should also be recognized that the tax structure is becoming increasingly uniform. Because all localities and states have increased their budget needs, new taxes have been imposed. Property taxes, one of the oldest forms of taxation, are levied in all areas. Variations appear in the actual rates, in the ratio of assessment to actual value, in classification between real, personal, tangible and intangible property, and in the existence of special taxes on industry and business. A major form of taxation is the expanding use by states of the corporation income tax. As of January 1961, thirty-two states imposed a tax ranging from one to 8 per cent of net earnings on corporations (42).

In the evaluation of future tax conditions of a given state, a fairly satisfactory factor is an understanding of the net debt of the state. This gives some indication of future revenue needs. Nevertheless, except for particular local conditions, it is generally felt that few industries have developed in a region solely because of a favorable tax structure. Taxes are too omnipresent to be a vital localizing factor. It is equally true that few industries have migrated from a region because of an unfavorable tax structure. Taxes are normally only one of many factors which give an area an unfavorable cost structure and cause the movement of industry to more favorable locations.

Government. Government—local, state, or national—can play a decisive role in the establishment of manufacturing. In socialist and communist countries, the establishment and development of manufacturing are frequently controlled directly by governmental policy. Under such situations the location of industry follows the dictates of governmental desire. As a consequence the location of industry may be a response to political or military dictation rather than the operation of economic advantage.

In other areas of the world the influence of the national government varies from time to time. During periods of national emergencies, such as World War II and the Korean War, governmental influence is demonstrated in a number of ways (85). The growth of industry is encouraged in areas where it appears that it will not suffer from an enemy attack. Thus, in the past, industries that are located in the interior of the country have been given a greater subsidy to expand than those in coastal positions. Also, in times of emergency, the entire productive capacity of a nation must be utilized to the maximum degree. World War II gave much impetus to the growth of industry in nonindustrial areas. This type of industry, once established, persists after the initial reason for its development has long disappeared. The national government may also influence the location of industry during peacetime periods by encouraging the growth of manufacturing within economically depressed areas in order to stabilize the economy. Direct loans at low interest rates granted to firms that will establish industry in a depressed economic region are a common governmental approach.

State and local inducements. As the American economy becomes more highly urbanized, communities depend increasingly on manufacturing to maintain themselves. The attraction of new industry has become the primary goal of many chambers of commerce, and millions of dollars are spent annually in advertising by all types of industrial development groups. The securing of a new industry in a given area is becoming increasingly difficult. Competition among cities and states is keen. Essentially every state government has an agency to promote industrial development. Thousands of communities have developed some form of industrial development program.

The operation of an industrial promotion program has a number of aspects. One of the first steps is the preparation of a data book listing information pertinent to the localization of manufacturing. The making of initial contact with industrial prospects and arranging visits to the community are also necessary considerations. In certain instances the promotional agency, to attract new industries, may grant subsidies, such as lowered taxes, a rent free building, free water, or land for the industry.

The efforts of the promotional group may extend to other endeavors. For example, the evaluation of the physical appearance of the community may be critical in attracting new industry. Good hotel facilities, well-paved and well-lighted streets, well-maintained homes and parks, good schools, and hospitals—all create a receptive attitude in the minds of prospective manufacturers. Many towns do not gain industry because of traffic congestion, outmoded retail sections, or areas of slum dwellings. This is particularly true when a firm plans to transport its executive staff to a new location. The industrial promotional group may thus have the problem of considering many aspects of the cultural and economic environment of the town not directly associated with manufacturing.

The influence of the industrial promotional group on the localization of industry is growing in importance in the United States. Because many firms could operate successfully in a wide variety of locations, a specific location is frequently determined by the efforts expended in a given place to attract the company. This gives a considerable advantage to the larger communities that have sufficient resources to employ a well-trained industrial planning staff.

CRITERIA FOR MEASURING MANUFACTURING

The question of where manufacturing is located immediately raises the thought of how to measure the amount of manufacturing in a given locality (1). There are several criteria by which this amount can be measured. But different methods of measurement can produce quite different conclusions. It is important therefore that one familiarize oneself with some of the criteria—and the methods of using them—in order to understand better the maps which portray the locational patterns of this economic activity.

Number of establishments. Number of establishments (factories) is probably the simplest criterion for measuring amount of manufacturing in a place. It is the least confidential of all the industrial criteria; if authorities refuse to divulge any other information about manufacturing, they usually will tell how many factories exist in their locality. Similarly the United States Census of Manufactures, when listing data for individual cities or counties by types of industry, may withhold all other information except the number of establishments "in order to avoid disclosing figures for individual companies." Yet logically this criterion is of little significance in measuring a region's industrialization because it fails to recognize very meaningful attributes of factories. For example, a factory with only three employees is the equal of a factory employing 5,000 people. Each is one factory.

For decades the U.S. Census of Manufactures has used this as one of the categories by which it tabulates industrial statistics. Yet the value of such data is open to question; they therefore will receive little attention in this book. Indeed, some Census authorities have questioned the wisdom of devoting time and expense to compiling this information. However, before the criterion is discarded it might be a profitable research endeavor to investigate the correlation between number of establishments and other criteria by states, counties, and urban areas. Perhaps it would be found that correlations persist and that their patterns relate to size and type of industrial area.

Number of employees. Number of employees is the traditional and probably the most easily comprehended and widely used criterion for measuring manufacturing. Its advantage is that it is generally available (most firms are willing to release such information) and is directly related to other geographical characteristics of an industrial area. To illustrate, any change in a city's number employed in manufacturing is almost

certain to affect the demand for housing, trade, transportation, schools, and other municipal services in that settlement. Many of the other criteria could change and cause no such impact. The main disadvantage of this criterion is that it fails to recognize mechanization or differences in productive ability. Ten men in one factory may produce twice as much as ten men in a competing factory, especially if the former is mechanized.

Number of production workers. Number of production workers is a component of number of employees and tabulates only those individuals engaged in the actual change of raw materials into finished products. By counting only those on the production line and omitting clerical, managerial, research and other related personnel, a measurement closely related to actual manufacturing is obtained. Those contending that number of employees is more meaningful than number of production workers or wage earners point out that the salaried employees are equally essential to the existence of a factory; omission of them produces an unrealistic comparison of factory with factory or industrial region with industrial region.

Percentage of the labor force. Percentage of the labor force in manufacturing reveals those areas in which industry is relatively important. A map based on this criterion must be constructed and interpreted with caution. In the first place, a minimum absolute employment must be established below which ratios will not be computed; otherwise, an area with only six employees (if all were in manufacturing) would appear as 100 per cent industrialized, a misleading comparison with an area of 50,000 manufactural employees having a ratio of only 25 per cent industrialization because all employment totaled 200,000.

Value. Value measurements have certain advantages. They represent amount of manufacturing in a way unmatched by other criteria. There are five aspects of manufacturing for which value data are generally available and used for measurement purposes: value of raw materials, value of finished product, value added in the manufacturing process, value of labor, and value of capital invested.

Value of raw materials. Value of raw materials measures the dollar amount of materials being transformed in the manufacturing process. For years the U. S. Census of Manufactures employed this criterion in its published releases. However, it does not necessarily follow that a region processing a large amount of material will do more manufacturing than a region processing a lesser amount of material. This criterion is no longer widely used and the Census has discontinued its listing.

Value of finished products. Value of finished products leaving factories appears, logically, to be more realistic than value of materials entering the factory as an indicator of how much manufacturing is performed. These criteria include such diverse items as cost of raw materials, power, semifinished products and parts, transportation, taxes, insurance, and cost of maintaining and amortizing the plant. Because the manufacturing operations may take place in widely dispersed areas, the value of the finished product may contain many duplications of these items. For example, when a factory making automobile motors buys parts from specialized establishments and sells the finished motor to an automobile assembly plant, the value of each motor appears twice in the total value of manufactured output, and the value of the parts of the motor could appear three times. Some semifinished products, such as screws, could be counted four times.

Value added. Value added in the manufacturing process is probably the most meaningful value measuring stick, since it specifically measures the change in form or substance accomplished by manufacturing. Generally it represents the difference between value of materials used and value of product leaving the factory. Value added by manufacture provides the best census measure of the relative economic importance of manufacturing in different industries and different areas. It measures the approximate value created in the process of manufacture, that is, the contribution of manufacturing establishments to the value of finished manufactured products. Value added is calculated by subtracting the cost of materials, supplies and containers, fuel purchased, electric energy, and contract work

from the total value of shipments. It avoids, therefore, the duplication which appears when the criterion of value of products is utilized.[2]

Value of labor. Value of labor, generally expressed as "salaries and wages" when applied to employees, or "wages" if applied only to production workers, has the double advantage of being the major component in value added as well as indicating areal differences in labor's relative contribution to upgrading the value of materials being processed. For instance, two communities may each employ 10,000 people; if one pays an aggregate of $40,000,000 and the other $50,000,000 it can be argued that the latter is doing more manufacturing. It is probable that the impact of manufacturing upon the latter community will be different from that upon the former; with more money to spend, the 10,000 employees and dependents probably will support more retail trade, services, and banks in the second community.

On the other hand it may be contended that number of employees is more meaningful. If for example, two communities pay equal salary and wages, one to 10,000 people and the other to 12,000, it can be argued that the latter has more manufacturing, since industry makes a greater impact on the community—demanding more housing, more food, more clothing, and more municipal services. Whether value of labor is preferable to number of laborers is open to question. Indeed one could well investigate comparisons between these two criteria from county to county throughout the United States, noting which regions stand out more conspicuously in terms of the one, and those which are revealed more strongly by the other. Furthermore, it would be enlightening to determine coefficients of variation between the two absolutes—number of employees and value of their efforts—as they vary from county to county in the United States.

[2] United States Department of Commerce, Bureau of the Census, *Census of Manufactures, 1958,* General Explanations.

Value of capital invested. Value of capital invested is the best criterion reflecting amount of mechanization. It is widely known that a highly mechanized factory employing few people—for example a flour mill or a petroleum refinery—can produce quantitatively more than a slightly mechanized plant with a large labor force. The disadvantage is that a factory can be highly mechanized—and idle. Such data can be misleading.

All value data share two disadvantages. They vary with deflationary and inflationary trends, thereby giving misleading impressions of trends. Moreover, they are highly confidential. Rarely can a research man in the field gather sufficient value data to present a complete picture of manufacturing.

Power. Installed horsepower of prime movers is a useful measurement revealing the role of machinery in manufacturing. The United States Census formerly carried such information for industries but has deleted it from the recent Census of Manufactures.

Physical output. Physical output is useful in comparing industries producing comparable products. Two pen factories can be compared in terms of pens produced; automobile makers can be compared in terms of number of cars rolling off their assembly lines. Obviously this criterion cannot apply to unlike industries, such as in comparing a candy company with a steel company.

Importance of multiple criteria. The conflicting impressions of change in manufacturing given by different criteria is illustrated by the following data, selected for the industry identified as "blast furnaces" by the U.S. Census:

TABLE A.2

	1899	*1923*	*1954*	*Change: 1899-1954*
Number of establishments	223	169	85	Decrease
Number of wage earners	39,000	36,000	31,108	Decrease
Value of product (millions)	$206	$1007	$2741	Increase
Tons produced (millions)	13	36	58	Increase

Source: United States Census of Manufactures, U.S. Department of Commerce, Washington, D.C., and Minerals Yearbook, U.S. Department of Interior, Washington, D.C.

Each of the foregoing criteria has advantages and disadvantages for measuring the amount of manufacturing. No single criterion is entirely satisfactory; each provides only partial revelation of how much manufacturing is in a given place. The need is for a concise method for measuring industry in a way to represent its significant variables. The goal may be reached in part by wise use of these criteria, such as combining them into ratios, or even formulae, for comparing industrial regions.

METHODS OF MEASURING AND MAPPING MANUFACTURING

There are numerous possible methods by which the absolute measurement discussed in the previous section could be used to reveal quantitatively and qualitatively the amount and location of manufacturing in an area. In the past decades several efforts have been made to analyze the location of manufacturing.

Rather surprisingly, the first thorough investigation was not by an American but by a Swedish scholar, Sten de Geer (18). This epochal work, published in 1927, remains an outstanding effort at mapping the location of American industry and analyzing a diversity of features with which it is associated. De Geer's method was to map the number of wage earners in manufacturing in all cities of 10,000 or greater population. This criterion was chosen instead of value-figures because "these have closer relations to the number of inhabitants and to other geographical factors, and represent a still better way of measuring manufacturing activities." Sten de Geer's main map showed the location of all cities qualifying with at least 2,000 industrial wage earners. Observing the pattern thus portrayed, de Geer commented: "This survey made it clear that manufacturing cities occur by groups in several eastern and central states or in parts of them, while most southern and western states have few and rather isolated or dispersed manufacturing cities. Thus there is but one closed manufacturing belt within the eastern and central states."

Alfred J. Wright delimited the manufacturing districts of the United States on the basis of value added to materials by the manufacturing in cities of 10,000 population and over (75). Wright considered value added the most desirable criterion to measure manufacturing in that it provides a weighted base, since it includes all factors of production. This base is particularly applicable to mapping manufacturing in the United States, where the value added to material is one-third greater than in Great Britain and Germany combined; where installed horsepower is twice that of these two countries; but where wage earners in manufacturing number approximately the same as those for the two European nations.

Using aggregate horsepower of prime movers and electric motors by county units, Helen Strong presented an isopleth map of relative density of power used. From this as well as from personal observations and other elements (not mapped statistically) she prepared maps of regions with three degrees of manufacturing density (64). As a result of using isopleths the maps on manufacturing indicate considerable manufacturing in areas where little manufacturing exists. This approach emphasizes those industries which are high consumers of electricity. This method, however, illustrates the shortcomings of utilizing a single criterion.

Clarence F. Jones stated that because manufacturing in the United States has great diversity, marked complexity, and wide distribution, it could best be portrayed areally by using the data by county units of several important criteria of manufacturing. These included wage earners, power used, and value added (38). The areas of manufacturing were developed by superimposing the three individual criteria maps. As a result of this approach several small manufacturing centers were not represented. However, the areas represented on the map of manufacturing distribution accounted for more than 95 per cent of all manufacturing in the United States.

Another method is the combining of absolutes into ratios. Unquestionably, additional light is shed on the degree of manufacturing in any one place and the regional pattern of manufacturing in general by expressing one absolute value in relation to another. For instance, the ratio of total employment to employment in manufacturing reveals areas which, relatively, are the most highly indus-

trialized. Conceivably, there could be instances where the most meaningful measurement would be the ratio of industrial employment to population. Richard Hartshorne employed this technique in his effort to delimit the most industrialized areas of the United States (29). He reasoned that the need for manufactured goods by the populace in any given area would require an industrial labor force numbering one-tenth the total population. Thus, a county with many employed in manufacturing would not necessarily qualify as highly industrialized; if it had a very large population it might well be less industrialized, according to this method, than a county with fewer factory workers and considerably less population. Hartshorne actually used number of production workers instead of employees.

A map based on the ratio of employment to salary and wages paid should shed light on the technical level of industry in various places. The same could be said for such ratios as value added : employment and power consumed : employment. Other ratios such as value added : value of materials, employment : number of establishments, production workers : employees, and value of product : value of materials are just a few of the many possible ratios by which manufacturing can be measured and mapped.

Another method is the multiple-criteria system. John Thompson has suggested the combination of five separate criteria in order to reveal both the magnitude and the intensity of manufacturing in a given place (67). An index was established for each criterion (employment in manufacturing, value added, salaries and wages, total employment in all economic activity, and population). Indexes were based on the average of magnitude and intensity prevailing in fifty selected standard metropolitan areas. For instance, average manufactural employment in these fifty places was 70,000; a place employing 35,000 would have an index of "50", an index of "200" would apply to a place employing 140,000. The first step in the method is to determine magnitude ratings, which Thompson calculated for the first three criteria listed. Averages for each (for fifty metropolitan areas), upon which index numbers were based, were adopted as follows:

Employment in manufacturing	70,000
Value added	$200,000,000
Salaries and wages	$100,000,000

Each place then was rated in terms of three index numbers. If the three resulting indexes were 49, 42, and 44, the summary rating of magnitude would be 45, or an average of the trio. Categories of places based on these summary ratings are arbitrarily established as follows:

Class	*Magnitude: summary rating*
A	over 800
B	400-799
C	200-399
D	100-199
E	50- 99
F	25- 49
G	12- 24
H	6- 11
I	less than 6

The second step is to determine intensity ratings in terms of three ratios: manufactural employment to total employment, manufactural employment to population, and value added to population. Indexes are then based on the following averages for the fifty metropolitan areas:

ratio: manufactural to total employment	.30
ratio: manufactural employment to population	.11
value added per inhabitant	$310

Again each place can be given a trio of index numbers, the average of which is a summary rating of intensity. These ratings likewise are grouped into nine classes:

Class	*Intensity: summary rating*
I	over 200
II	150-199
III	125-149
IV	100-124
V	75- 99
VI	50- 74
VII	25- 49
VIII	12- 24
IX	less than 12

Application of this method to Detroit, Cleveland, and Columbus provides the ratings shown on page 18.

	Detroit	*Cleveland*	*Columbus*
Index: employees in manufacturing	794	384	78
Index: value added	800	425	76
Index: salaries and wages	979	459	81
"Summary rating of magnitude"	858	423	79
Magnitude Class	A	B	E
Index: mfg. emp.: total emp.	170	158	101
Index: mfg. emp.: population	182	179	108
Index: value added: population	183	197	105
"Summary rating of intensity"	179	178	105
Intensity Class	II	II	IV

By this system Detroit is classified A-II, Cleveland, B-II, and Columbus, E-IV.

A further method measures the concentration of manufacturing by means of an index of concentration developed by Garver, Boddy, and Nixon (23). This system is particularly applicable to measuring and mapping individual industries such as the shoe industry and involves five steps. Suppose, for example, that one wishes to determine the degree of concentration of shoe manufacturing in the 50 states. The first step is to compute for each state the ratio between the number of its shoe workers and its population. Second, the states are arranged in order according to their ratios thus determined. The next step is to add the "absolute" number of shoe workers, state by state, beginning with the first state listed in the order established in the second step. This adding continues only through as many of the states as is necessary to aggregate 50 per cent of the nation's shoe workers. In other words, half of the nation's shoe workers are concentrated in x number of states occurring at the top of the list mentioned above. The fourth step is to determine the aggregate population of x states. Fifth step is to compute the percentage of the nation's population held by x states. This percentage will be low if the industry is highly concentrated; it will be high if the industry is widely dispersed. Final step is to subtract this percentage from 100, giving a number identified in this system as "the index of concentration." Thus, if 50 per cent of the nation's shoe workers are in an area containing 8 per cent of the nation's population the index of concentration is 92 for the shoe industry. Close inspection will reveal that by this system no index of concentration could attain 100; nor could it fall below 50, which would be the index for a ubiquitous industry.

The National Resources Planning Board employed still another system, which consists of three related methods (80). The first method provides a location quotient which actually is a ratio of ratios and is designed to reveal the relative concentration of an individual industry within a given place as viewed from the standpoint of that place. For example, the location quotient of the shoe industry in place x is derived as follows:

$$\text{Location Quotient} = \frac{x\text{'s shoe workers as per cent of } x\text{'s mfg. employment}}{x\text{'s per cent of the nation's mfg. employment}}$$

The second method, the "coefficient of localization," reveals the relative concentration of an individual industry in a given place from the viewpoint of the nation's total industrial structure. It is derived for each area (which has a "location quotient" exceeding 1) by subtracting its percentage of the nation's manufactural employment from its percentage of the nation's employees in the specific industry under question.

The Board's method also contained a third concept, "location coefficient," which is derived for any individual industry by adding the coefficients of localization for all eligible areas (which are not overlapping) as indicated above and dividing the sum by 100. The resultant represents that industry's location coefficient.

The student concerned with understanding the locational patterns of manufacturing must realize that the impressions gathered from measurements of industry reflect the peculiarities of criteria adopted for those measurements. The question of how best to measure the areal distribution of manufacturing has

interested regional analysts for many years and persists in challenging thoughtful students to devise better methods than those already proposed. The search is for the method which will reveal most accurately the location of manufacturing, and the areas which, because of industrialization, are discernible as manufacturing regions.

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PART ONE

WORLD PATTERN OF MANUFACTURING

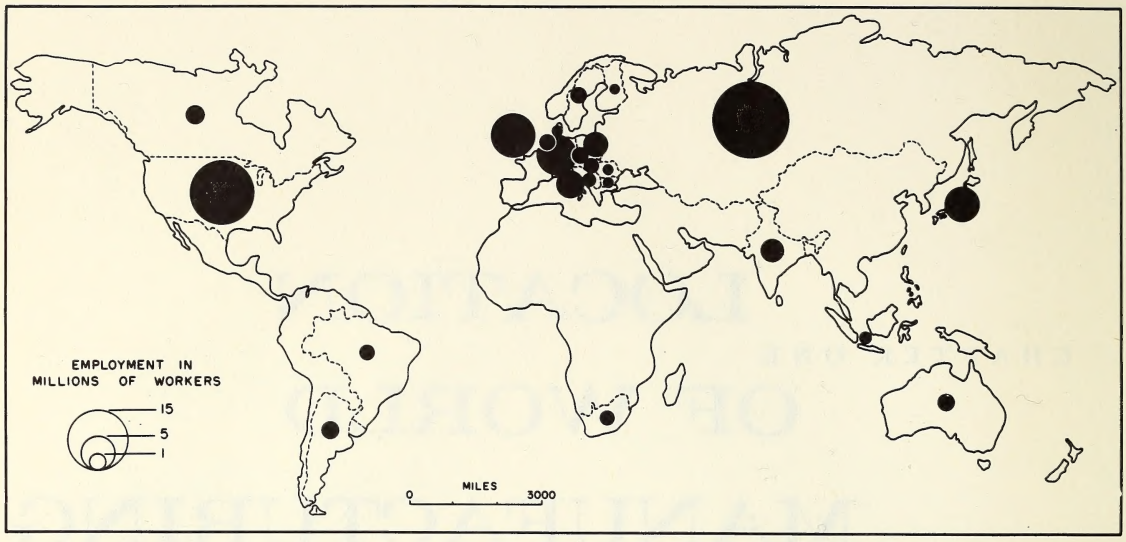
CHAPTER ONE

LOCATION OF WORLD MANUFACTURING

Manufacturing is extremely uneven in its distribution throughout the world (2). The precise locational pattern, moreover, is not easy to ascertain. Some countries have had no censuses of industrial activities; other countries withhold data. For those countries that do have censuses of industrial activity, there is no uniformity in collecting manufacturing data. In nearly all countries some limiting criteria are applied. In some cases, only factories with a given number of wage earners are counted, or the census is restricted to factories which have a specified output. For example, only factories with an output of more than $5,000 annually are counted in the United States; in other countries a specific amount of motive power must be consumed by the factory before it is considered. In the underdeveloped countries small factories are more likely to be reported, while in the industrialized nations only the larger factories are counted.

Regardless of census limitations, however, data on number of employees and value of output are sufficient to present fairly adequate distributional patterns of the world's manufacturing activities. The importance of manufacturing in a particular nation will vary depending upon the criteria used. For example, when employment is used, India and China appear as major industrial nations. However, when the value of output is used to measure manufacturing, these nations are of little importance. In contrast, the United States, the Soviet Union and the western European countries dominate the world in value of output.

Employment in manufacturing. A census of manufacturing employment is not available for all countries of the world. Therefore no precise figures exist as to the number of persons engaged in manufacturing. However, the number can be reasonably estimated on the basis of statistics available for areas representative of different stages of economic development. According to censuses of population, the proportion of the labor force engaged in manufacturing and handicrafts ranges from



1.1. World—Factory Employment.

less than 10 per cent in such primarily agricultural countries as Colombia, Bolivia, Turkey, Iraq, Iran, Egypt, Thailand and most African countries to over 30 per cent in the highly industrialized countries such as Switzerland, the United Kingdom, Belgium, West Germany, and Luxembourg.

In 1960 it was estimated that 185 million workers were engaged in manufacturing and the handicraft industries in the world (Map 1.1). Of this number possibly not more than 95 million were employed in industrial establishments that could be classified as factories. Among the countries for which statistics of factory workers are available, the Soviet Union ranks first in total number followed by the United States. Next in order are Germany and the United Kingdom, Japan, France, and Italy. In these seven countries, factory manufacturing employs about 70 million workers, or over 70 per cent of the world total.

In the United States and Canada nearly one-third of the labor force is engaged in manufacturing. In the United States the number totals over 16 million. In Canada the corresponding number is just over 1,350,000 persons. Within Latin America the number of workers in manufacturing and handicraft industries totals about seven million. In Middle America the number of people employed in manufacturing and handicrafts can be estimated at 1.8 million. In South American countries the figure varies from 9 to 20 per cent. Argentina and Brazil each have about 1.4 million workers in manufacturing industries out of a total in South America of about 5.2 million.

Europe, excluding the Soviet Union, is a major area of industry, with about 60 million manufactural workers. The intensity of employment varies greatly from country to country. The United Kingdom, with about eight million workers, has the largest labor force in manufacturing, followed by West Germany, with over 7.5 million. In contrast to such highly industrialized countries as Belgium, Switzerland, West Germany, France, and Italy, a number of European countries—such as Spain, Romania, Albania, and Bulgaria—have developed little manufacturing.

Asia—excluding the U.S.S.R.—with an estimated 65 million workers in manufacturing and handicrafts, has the largest number of industrial workers. However, of this number not more than ten or eleven million workers are employed in factories. The remainder are found in small establishments and home production. Of the Asian workers, about 32 million are located in China and around 20 million in India. Japan, with about nine million industrial workers, has the best-developed factory system. The Middle East has over three

million workers in manufacturing and handicrafts. The percentage of the labor force in manufacturing varies from less than 2 per cent in Thailand to about 17 per cent in Japan.

Africa with a population of 180 million has an estimated 7.7 million industrial workers. The Union of South Africa has the largest labor force in manufacturing, totaling about 700,000 followed by Egypt with 275,000. The area of Oceania has about 1.2 million workers in manufacturing. Of this number over 1,000,000 are found in Australia and 165,000 in New Zealand.

Value of production. The geographic concentration of manufacturing in the world is much greater in terms of value of output than in terms of employees. Statistical data are not complete for all countries of the world and comparable figures from country to country are difficult to obtain because of the lack of a clear distinction between the concepts of gross and net value of production.

Although limitations are evident in determining the value of manufactured goods on a world basis, estimates are available for different periods and general trends can be perceived. One of the earliest computations appears for 1888 (1). The output for the world and the twelve leading nations follows:

TABLE 1.1

	1888 (in millions)
World	$22,370
U. S.	7,215
Great Britain and Ireland	4,100
Germany	2,915
France	2,425
Russia	1,815
Austria-Hungary	1,265
Italy	605
Belgium	510
Spain	425
Sweden	250
Netherlands	175
Switzerland	160
Other Countries	510

Source: M. Mulhall, *The Dictionary of Statistics,* 4th Edition, London, 1889.

It is evident that the United States and the northwestern European nations dominated industrial output in the latter part of the nineteenth century.

By 1913—on the eve of World War I—a number of changes had altered the industrial pattern of the world. The United States was even more firmly entrenched in first place. Germany and the United Kingdom had, however, changed positions. Russia remained in fourth place until the 1917 Revolution. Japan, Canada, and British India—industrial newcomers—surpassed Spain, Sweden, the Netherlands, and Switzerland in manufacturing output.

There are no comprehensive world industrial statistics for the World War I period. The war left most of the leading European nations economically devastated. As soon as the war ended, however, economic recovery began, and, though retarded briefly by the 1921 depression, the European economy continued to rise steadily until 1929. A peak in industrial output of nearly 48 per cent above the 1913 level for the world—excluding the U.S.S.R.—was reached in 1929. The world economic depression of the early 1930's eliminated these gains, and in 1932 the world output was below the 1913 level. Recovery by the end of the 1930's was not complete. Except for the 1936-38 interlude, neither the United States nor the world regained the 1929 peak output during the period prior to World War II.

TABLE 1.2

	Percentage of world output
United States	34.41
United Kingdom	10.42
Germany	10.32
U.S.S.R.	9.95
France	5.02
Japan	4.00
Italy	2.51
Canada	2.23
Poland	1.77
Czechoslovakia	1.58
Belgium	1.49
Sweden	1.12
India	1.12

Source: W. S. Woytinsky and E. S. Woytinsky, *World Population and Production* (New York: The Twentieth Century Fund, 1953).

For 1937, the Statistical Office of the United Nations estimated that the industrial production (including minerals) of the world was about $89 billion. According to the U.N.

index, the percentage distribution of the 13 leading industrial nations was as shown in Table 1.2.[1]

This table represents about 86 per cent of the world's total industrial output based on value.

Between 1938 and 1948, manufacturing production was affected adversely in such areas of military activity as the Soviet Union, and Japan, as well as Germany and certain other European countries. Many other nations were faced with adjusting to a marked political change in the world economy. The level of industrial output in Europe was about the same in 1948 as in 1938, but was substantially lower in Asia. This European stability is attributed primarily to the sharp drop in the output of West Germany and Italy and the modest growth in other European countries. In Asia—although India and Pakistan experienced modest increases—the decline of Japan caused the substantial drop in Asian industrial output. The western industrial zones of the Soviet Union were greatly damaged during World War II and industrial output declined during this period. In contrast to the above trends, industrial production rose greatly in nearly all the nations of the Western Hemisphere, Oceania, and most of the African countries.

In the period 1938-1948, Canada and the United States experienced the highest annual rate of growth in manufacturing. Following these countries were some of the least industrialized countries, demonstrating especially the substantial growth in the industrial activity of Latin American countries such as Brazil and Colombia. The pace of Latin American industrialization was quickened during the war period, not only because of increased demand—principally from the United States—for its raw and semifinished materials, but also because of the need to supply from domestic manufacturers a larger portion of the expanded demand at home for goods.

In 1947, the U.N. index of world industrial production indicated that output totaled $182.2 billion at current United States prices.[2] Of this amount, mining represented $29.4 billion, while manufacturing accounted for $152.8 billion. Because mining is not separated from manufacturing in the production statistics of many countries, the following table relates to industrial production as a whole:

TABLE 1.3

	1947 (*total in millions*)
United States	$86,910
U.S.S.R.	18,000
United Kingdom	15,630
France	6,760
Canada	5,560
Italy	3,640
Poland	2,880
Japan	2,450
Sweden	2,420
Czechoslovakia	2,100
Belgium	1,960
India	1,680

Source: Patterns of Industrial Growth, 1938-1958, United Nations, New York, 1960.

The United States and Canada accounted for approximately one-half the world's industrial output in 1947. An additional 20 per cent was concentrated in northwestern Europe and 10 per cent more was localized in the Soviet Union. The remaining 20 per cent was widely distributed throughout the world, with significant concentrations in India and Japan.

In the early post-World War II period a number of significant trends were discernible. In general the industrial output of the countries of the world grew rapidly. The volume of industrial production increased most in those areas which after the war were faced with the reconstruction of their economy and the expansion of their industrial plant. Thus, the highest rate of growth occurred in areas which experienced a modest increase or a decline in output between 1938 and 1947. For example, the average annual rate of increase

[1] These values do not include handicrafts. Inclusion of handicrafts would raise the net value of industrial output in 1937 to about $96 billion and increase the relative share produced by the underdeveloped nations.

[2] Industrial production in the United States was 65 per cent greater in 1947 than in 1937, while the world index increased by only 19 per cent. The relative share of the United States in the world's industrial output increased from 34.4 per cent to 47.7 per cent. In 1947 the value of the U.S. industrial output was $86.9 billion, of which $74.4 billion was value added by manufacturing and $12.5 billion for mineral products.

between 1948 and 1953 was 11 per cent for the six countries of the European Common Market, taken as a single unit. In Asia, the annual rate of output was high in such countries as Japan, the Republic of Korea, and the Philippines. Although the growth of manufacturing in Oceania was not as great as in Europe and Asia, it was still close to 6 per cent per year. This growth was largly a response to the need for replacing and expanding industrial capacity, deferred during the war, as well as the growing market for the exports of these countries (12).

In Latin America, the average annual rate dropped from 5 per cent in 1938-1948 to 4 per cent between 1948 and 1953, primarily because of the decline in the level of Argentina's output. In the United States and Canada the annual increase was about 5 per cent. In a number of the European countries, such as Sweden, Yugoslavia, Belgium, and Luxembourg, the increase was only about 2 per cent per year. The growth in industrial output approximated only 1 per cent for India and Pakistan. In the case of the Indian subcontinent, the persistent economic and political problems resulting from partition, the relatively slow start of industrial development and the depressed state of the textile industry contributed to the low rate of growth. Most economists agree that during the early postwar period the rate of growth in the Soviet Union was at a high level.

In summary, most countries attained and sustained a significant industrial output between 1948 and 1953. About 70 per cent of the countries for which information is available experienced average annual increases of 4 per cent or more in manufacturing activity. Moreover, except for the 1949-1950 recession in the United States—which did not significantly affect other parts of the world—the expansion in output was relatively steady (12).

Between 1948 and 1953, industrial employment increased much less than the volume of industrial production in nearly all countries. The increase in output was also much greater than the rise in employment for each of the classes of industrialization. The greater increases in industrial output than employment reflected substantial rises in labor productivity, which ranged from a low of 2 per cent annually for Asia—excluding Japan—to 9 per cent annually for the Common Market countries.

Since 1953 a number of factors have affected world manufactural growth. Possibly the most significant single factor was the 1957-1958 world economic recession. This recession brought the 1958 level of output for the United States and Canada down to their 1953 level, and depressed the 1958 level for most of the rest of the world below what it otherwise would have been, excluding the Soviet Union, Eastern Europe and mainland China. Despite the depressing effects of the 1957-1958 recession, most parts of the world experienced high rates of growth between 1953 and 1961. For example, the average annual expansion in industrial output was about 6 per cent for Latin America, Europe and Oceania, from 7 to 10 per cent in the Soviet Union, and over 10 per cent for Asia.

The distributional pattern of world manufacturing has not been altered greatly in recent years. However, the relative position of nations has undergone some adjustment. The United States has not expanded its manufacturing at the pace of a number of countries and has declined relatively. Manufacturing in the Soviet Union and most of the western European countries has increased greatly. As a result of this growth pattern the world's industrial production is even more heavily concentrated on both sides of the North Atlantic than prior to World War II. In the area from the Mississippi River in the United States—including southern Canada—across the Atlantic Ocean to northwestern Europe and extending to the Kuznetsk Basin of the Soviet Union, is found the major world industrial belt. Within this area about 30 per cent of the world's population produces about 90 per cent of the world's industrial output. In contrast the remainder of the world, with 70 per cent of the population, produces about 10 per cent of the manufactured goods. Of the industrial areas lying outside the major concentration, western United States, Japan, China, and India are the most important.

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CHAPTER TWO

ANGLO-AMERICA

The most highly developed belt of manufacturing in the world lies in North America, extending inland from the Atlantic seaboard for more than a third of the distance across the continent. Most of this belt is in northeastern United States, yet a significant smaller development has taken root north of the border in Canada. Manufacturing occurs in a number of other areas in these countries in regions separated from the main manufacturing belt.

UNITED STATES

Manufacturing occupies an increasingly important position in the American economy. The U.S. Census of Manufactures indicated that 16,046,945 people were employed in factory enterprises in 1958, either as production workers or as supervisory, research, clerical and sales personnel. This labor force represented about 30 per cent of the nation's total employment and is in sharp contrast to the 1939 situation, when manufacturing's 9,622,923 employees represented 24 per cent of America's employment structure. Manufacturing is now the leading economic activity in the United States. The conspicuous growth of manufacturing is but a continuation of a long trend discernible throughout most of America's economic history. The United States in five generations has changed from an essentially primary producer (agriculture, forestry, mining and fishing) to a secondary producer (manufacturing and trade).

Trends in the United States as a whole. Changes in industrial employment in the United States will be measured first in absolute terms and then in relative terms. This will be followed by a discussion of trends in individual industries.

Absolute growth. During the period 1939-1958 the number of employees in manufacturing in the United States increased 66.7 per cent. About one-half of the increment occurred in the northeastern portion of the country. This is in contrast with the rather widespread conception that manufacturing is migrating

from the older industrial areas of the North to the South and West. Table 2.1 lists the 30 metropolitan areas, as defined by the Bureau of the Census, which added at least 20,000 manufactural employees. A growth of 20,000 employees has been selected arbitrarily to segregate industrial areas which experienced the largest growth. Twenty-two of the 30 areas are in the northeast quadrant of the nation. Only four, Atlanta, Birmingham, Louisville, and Houston, are in the South; three are on the West Coast—Los Angeles, San Francisco, and Seattle—and one—Kansas City—is situated in the Interior. The Northeast had nine industrial nodes which expanded their industrial employment more than did the South's leader, Houston.

TABLE 2.1

Absolute Industrial Growth in Metropolitan Areas 1939-1958

	Increase in total manufactural employees (000)
1. New York-Northeastern New Jersey	713
2. Los Angles-Long Beach	557
3. Chicago	240
4. Philadelphia	144
(Subtotal of first four areas 1,654)	
5. Detroit	99
6. St. Louis	95
7. Cleveland	89
8. San Francisco-Oakland	89
9. Pittsburgh	88
10. Minneapolis-St. Paul	79
11. Baltimore	71
12. Seattle	69
13. Houston	65
14. Buffalo	59
15. Milwaukee	58
16. Kansas City	51
17. Dayton	48
18. Indianapolis	46
19. Atlanta	46
20. Cincinnati	42
21. Louisville	42
22. Rochester	39
23. Columbus	34
24. Allentown-Bethlehem	33
25. Syracuse	33
26. Akron	30
27. Albany-Schenectady-Troy	27
28. Birmingham	25
29. Springfield-Holyoke	25
30. Toledo	20

Source: Statistical Abstract of the United States, U.S. Department of Commerce, Washington, D.C.

The industrial areas which grew most were New York, Los Angeles, Chicago, and Philadelphia. These were the only metropolitan areas to add 100,000 or more manufactural employees to factory payrolls. Furthermore, the combined growth of these four leaders was 1,654,000 workers. This was 25 per cent of the nation's total growth.

Between 1939 and 1958, the basic pattern of manufacturing in the United States changed little. The conclusion is that during this 19-year period, the major regions which already had the most industry were the ones receiving the most additional industry. The Northeast —the main manufacturing belt—continued to experience the largest growth.

As a result of changes during the 1939-1958 period, the rank of America's largest industrial centers has been somewhat altered (Table 2.2). Philadelphia lost its third place position to Los Angeles-Long Beach. Los Angeles rose from eighth to third place. Philadelphia and Detroit dropped from third and fourth place to fourth and fifth place respectively. Boston, Cleveland, Milwaukee, Buffalo, and Cincinnati also declined in industrial status.

Relative growth. The regions which grew the most between 1939 and 1958 did not necessarily grow the fastest. There is a difference between amount of growth and rate of growth. Amount of growth is measured in terms of increased numbers, while rate is measured in terms of percentages.

Within the nation the most rapidly expanding industrial region extends from northern Ohio through southern Michigan, northern Indiana, northeastern Illinois and southeastern Wisconsin. There are many other areas where manufactural employment increased, but none is as extensive as this midwestern industrial zone. Most of America's rapidly growing industry is located here. Within the main industrial belt of the country the areas of New England, New York, Pennsylvania, New Jersey, and Maryland have lagged behind the national averages. To the west of these states the prevailing rates of growth were ahead of the national average.

Outside the major manufacturing region, a number of areas experienced significant growth. Within the South the greatest increases occurred on the Texas Gulf Coast.

TABLE 2.2

Rank of Leading Industrial Areas

	1958		*1939*	*Growth 1939-1958*
	Rank	*Total manufactural employees (000)*	*Rank*	*Total manufactural employees (000)*	*in total manufactural employees (000)*
New York-N. E. New Jersey	1	1805	1	1092	713
Chicago	2	856	2	616	240
Los Angeles-Long Beach	3	728	8	171	557
Philadelphia	4	538	3	394	144
Detroit	5	467	4	368	99
Pittsburgh	6	318	6	230	88
Boston	7	298	5	290	8
Cleveland	8	264	7	175	89
St. Louis	9	256	9	161	95
Baltimore	10	197	11	126	71
San Francisco-Oakland	11	190	14	101	89
Milwaukee	12	185	10	127	58
Buffalo	13	176	12	117	59
Cincinnati	14	151	13	109	42
Minneapolis-St. Paul	15	144	15	65	79

Source: Statistical Abstract of the United States, U.S. Department of Commerce, Washington, D.C.

Virginia, the Carolinas, and Georgia are characterized by slowly rising manufactural employment. The South has no wide expanse of rapidly growing areas. To be sure, isolated localities such as Houston are conspicuous, but in terms of industrial growth the South lacks a counterpart to the Midwest.

The industrial expansion on the West Coast is largely limited to a few major cities. Los Angeles has grown at a fabulous rate, but a considerable portion of the West Coast has lagged behind the national rate of growth.

It is in terms of relative growth that the South and the West Coast can claim certain leadership honors. By this criterion Los Angeles, Houston, and Seattle rank ahead of all other American cities. Table 2.3 lists the 23 fastest growing industrial areas, selected from the 50 largest industrial areas. Los Angeles led with 325 per cent; Houston was second with 240 per cent and Seattle ranked third with 150 per cent. Six industrial areas grew at a rate exceeding 100 per cent. It is important to note that 15 of the most rapidly expanding manufacturing cities in the nation are in the North, three are on the West Coast, four in the South and only one, Kansas City, is in the Interior.

Industrial trends. Just as certain industrial areas grew more rapidly than others, so certain industries grew more than other industries. The United States Census of Manufactures divides manufacturing into 20 groups of industries. Six of these grew more rapidly than the national average between 1939 and 1958; twelve grew more slowly, and three experienced an absolute decline in employment (Table 2.4).

Of the industries which grew most rapidly, the metal industries experienced the greatest gains. The six industries—primary metals, fabricated metal products, machinery (except electrical), electrical machinery, transportation equipment, and instruments and related products—in this group expanded at the rate of 109 per cent. The two which grew most rapidly were electrical machinery, 200 per cent, and transportation equipment, 128 per cent. Every phase of metal manufacture, except the primary industry, exceeded the national rate. This growth has given the metalworking industries a larger share in the nation's industrial structure. In 1939 metal industries represented only 31.9 per cent of the nation's employment in manufacturing but in 1958 their proportion was 40.1 per cent. Only three of the other general groups of industries grew at a rate significantly above the national average: chemicals, 80.7 per cent, pulp, paper and products, 75.9 per cent, and miscellaneous industries, 166.8 per cent.

Six categories of industries—printing and publishing; lumber and wood; stone, clay, and

TABLE 2.3

Relative Industrial Growth in Metropolitan Areas 1939-1958

	Percentage gain	*Total employment in manufacturing (000)*		*Absolute gain (000)*
		1939	*1958*	
1. Los Angeles-Long Beach	325	171	728	557
2. Houston	240	27	92	65
3. Seattle	150	46	115	69
4. Atlanta	124	37	83	46
5. Minneapolis-St. Paul	121	65	144	79
6. Kansas City	100	51	102	51
7. Dayton	98	49	97	48
8. Columbus (Ohio)	97	35	69	34
9. Syracuse	94	35	68	33
10. Louisville	93	45	87	42
11. Indianapolis	92	50	96	46
12. San Francisco-Oakland	88	101	190	89
13. New York-N.E. New Jersey	65	1092	1805	713
14. Birmingham	65	38	63	25
15. St. Louis	59	161	256	95
16. Rochester	58	67	106	39
17. Albany-Schenectady-Troy	58	46	73	27
18. Akron	57	52	82	30
19. Baltimore	56	126	197	71
20. Springfield-Holyoke	54	46	71	25
21. Allentown-Bethlehem	53	62	95	33
22. Cleveland	50	175	264	89
23. Buffalo	50	117	176	59

Source: Statistical Abstract of the United States, U.S. Department of Commerce, Washington, D.C.

glass products; food and kindred products; primary metals; and rubber—had a rate of growth near the national average. Three industries—apparel and related products; furniture and fixtures; and petroleum and coal products—had low rates of employment growth, lagging far behind the others.

The textile mill-products industry experienced a notable absolute decline in employment from 1939 to 1958. Because of this decline the textile industry lost its leadership in American manufacturing employment. In 1939 textiles ranked first with 1,163,000 production workers. By 1958 the number of textile workers had declined to 919,000, and seven manufacturing groups—transportation equipment, machinery (except electrical), electrical machinery, foods and kindred products, apparel, primary metal industries and fabricated metal products—exceeded textiles in employment. Besides the absolute decline in textile employment, the leather and tobacco industries experienced a slight decline in total numbers of workers.

Trends in major census regions. Manufactural regions of the United States are delimited by most authorities according to data provided by the Bureau of the Census of the Department of Commerce. The largest, most diversified fact-gathering organization in the world, the Bureau of the Census publishes several kinds of censuses, such as those on population, housing, agriculture, business and manufacturing. Beginning in 1899 a special Census of Manufactures was taken at five-year intervals. From 1919 to 1939 the interval was two years. World War II interrupted this series, but censuses of manufacturing have once again been taken for 1947, 1954, and 1958. These publications contain industrial data by states, counties, metropolitan areas and urban places to a degree of detail matched by no other nation. For the purpose of presenting the broad general patterns of the nation's economy, the Census groups its data into nine Census Regions, each an aggregate of entire states. Table 2.5 provides selected manufactural data for the nine regions.

TABLE 2.4

Leading United States Industries by Thousands of Employees

	1958		*1939*		*Gain or loss 1939-1958*	
	Number (000)	*Per cent of U. S.*	*Number (000)*	*Per cent of U. S.*	*Absolute (000)*	*Per cent*
Total	16046	100	9622	100	6424	66.7
Metals						
Machinery (except Elec.)	1549	9.6	680	7.0	869	127.8
Primary Metals	1073	6.7	1409	14.6	702	49.8
Fabricated Metals	1038	6.5				
Transportation Equipment	1480	9.2	649	6.8	831	128.0
Electrical Machinery	1005	6.3	335	3.5	670	200.0
Instruments	291	1.8				
(Total Metals)	6436	40.1	3073	31.9	3363	109.4
Fabrics						
Textiles	919	5.7	1163	12.0	—244	—20.9
Apparel	1168	7.3	849	8.9	319	37.5
(Total Fabrics)	2087	13.0	2012	20.9	75	3.7
Foods and Kindred Products	1667	10.4	1132	11.8	535	47.2
Woods						
Lumber and Wood	582	3.6	398	4.1	184	46.2
Furniture and Fixtures	358	2.2	344	3.6	14	4.0
(Total Woods)	940	5.8	742	7.7	198	26.6
Chemicals	730	4.5	404	4.2	326	80.7
Printing and Publishing	861	5.4	552	5.7	309	55.9
Stone, Clay, Glass	552	3.4	337	3.5	215	63.8
Pulp, Paper and Products	556	3.4	316	3.3	240	75.9
Leather	342	2.1	359	3.7	—17	—4.7
Rubber	232	1.4	149	1.5	83	55.7
Petroleum and Coal Products	179	1.2	139	1.5	40	28.7
Tobacco	84	0.5	96	1.0	—12	—12.5
Administrative and Auxiliary	557	3.6	—	—	—	—
Miscellaneous	822	5.2	311	0.3	519	166.8

Source: United States Census of Manufactures, U.S. Department of Commerce, Washington, D.C.

TABLE 2.5

Growth of Manufacturing in Census Regions in Terms of Total Manufactural Employees

	1958		*1939*		*Gain 1939-1958*	
	Number (000)	*Per cent*	*Number (000)*	*Per cent*	*Number (000)*	*Per cent*
United States	16046	100.0	9622	100.0	6424	66.7
East North Central	4255	26.5	2711	28.2	1544	56.9
Middle Atlantic	4151	25.9	2776	28.8	1375	49.5
South Atlantic	1892	11.9	1121	11.7	771	68.7
Pacific	1565	9.8	545	5.7	1020	187.1
New England	1400	8.8	1128	11.7	272	24.1
West North Central	963	6.0	498	5.2	465	93.4
West South Central	798	4.9	335	3.4	463	138.2
East South Central	783	4.8	413	4.3	370	89.6
Mountain	235	1.4	92	1.0	143	155.4

Source: United States Census of Manufactures, U.S. Department of Commerce, Washington, D.C.

The various regions of the United States have experienced different kinds of changes from 1939 to 1958. The East North Central Region is the largest of the nine industrial regions designated by the Census of Manufactures. With 4,255,000 manufactural employees it contains 26.5 per cent of American industry. The 1,544,000 workers added to factory payrolls in this region was larger than the growth in any of the other eight regions. Moreover, this region contains nine of the 30 cities listed in Table 2.1, the cities which led the nation in amount of growth.

The Middle Atlantic Region's increment of 1,375,000 workers between 1939 and 1958 was surpassed only by that of the East North Central. However, its 49.5 per cent rate of growth was exceeded considerably by the 56.9 per cent rate of the East North Central States, the area to which it relinquished the position of national leadership. Moreover, its share of all industry in the nation declined from 28.8 to 25.9 per cent. Only seven of the 30 cities that grew the most are located in the Middle Atlantic Region.

The South Atlantic Region ranks third in both amount of growth and amount of industry. Moreover, its 68.7 per cent rate of expansion was higher than the national average. Nevertheless, it has only two cities, Baltimore and Atlanta, appearing among the most rapidly growing industrial areas. The 771,000 workers added to this region's employment was about equivalent to the number added by the combined total of Los Angeles-Long Beach and Philadelphia.

By adding 1,020,000 workers to its industrial manpower, the Pacific Coast made the third largest advance. However, in rate of growth this region led all the rest. Its average of 187.1 per cent was far ahead of the national average. The nation's fastest growing large industrial city is Los Angeles, with a growth of 307 per cent. Moreover, Los Angeles enjoyed the second largest absolute growth, being exceeded only by New York. The Pacific Coast has increased its share of the nation's industry from 5.7 to 9.8 per cent.

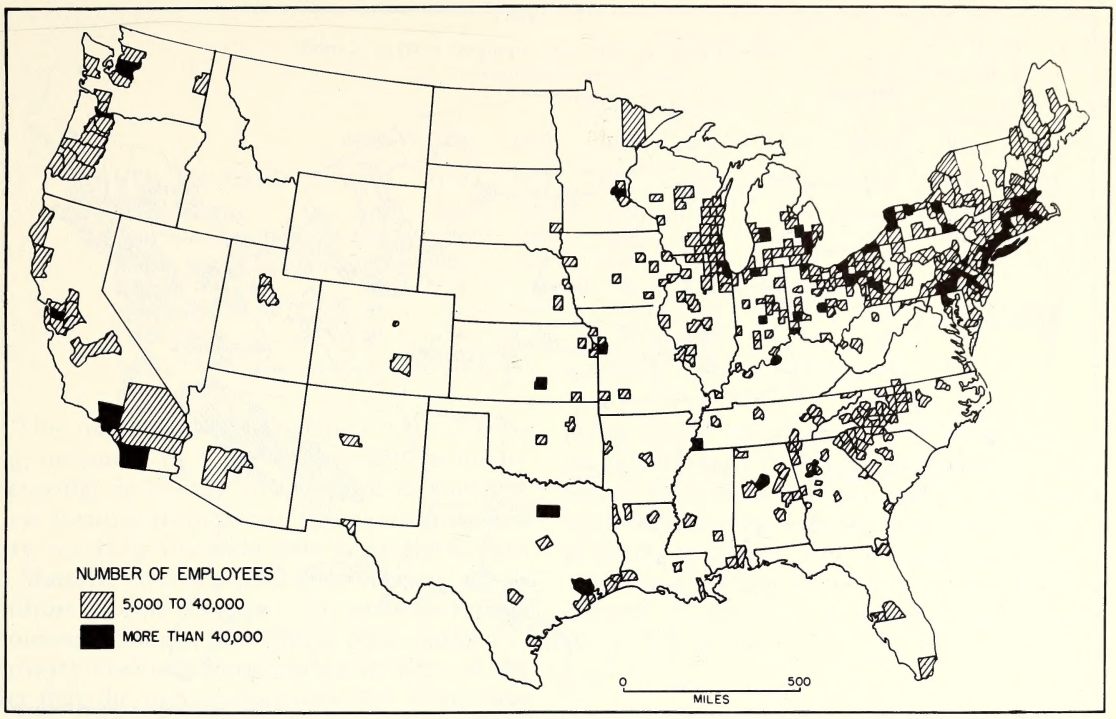
New England is not disappearing as a major industrial region. A region which possesses 1,400,000 production workers and which added 272,000 workers between 1939 and 1958 must continue to be an important industrial area. However, only one of the nation's 30 industrial areas which grew most rapidly is in New England. It is in rate of growth that New England lagged behind all the other regions. Its 24.1 per cent rate of growth was far below the national average of 66.7 per cent.

The fifth region of largest expansion is that of the West North Central, where the number of employees increased by 465,000. This was approximately the growth of the Chicago, Detroit, and Philadelphia industrial areas. St. Louis, Minneapolis-St. Paul, and Kansas City are among the nation's most rapidly expanding metropolitan areas. The 93.4 per cent rate of growth was considerably above the national average.

The West South Central Region added 463,000 people to factory payrolls. This growth was about 65 per cent of that of the New York City industrial area alone. The area which grew the most in this region was Houston, which added 65,000 employees. Manufacturing in the East South Central Region had an increment of 370,000 employees. Two of the nation's fastest growing cities, Louisville and Birmingham, are in the region, and the relative growth of 89.6 per cent was above the national average.

The Mountain Region added 143,000 workers, the same as the growth that occurred in Philadelphia. Nevertheless, this represented an increase of 155.4 per cent, a rate surpassed only by that of the Pacific Coast.

Useful observations regarding the regional differentiation of manufacturing can be drawn from the nine census regions. However, this system provides a generalized picture and does not permit a refined regional analysis. Manufacturing is not distributed uniformly through each region; each has substantial portions devoid of industry. Within each census region is a significant pattern in which conspicuous subregions are discernible. A more detailed system of regional delimitation is required to identify these. Moreover, the delimitation of regions in terms of entire states has the disadvantage of fragmenting some industrialized urban nodes and in other instances combining some clearly distinct industrial nodes which logically should be separate. For example, the concentration of manufacturing in and around New



2.1. United States—Counties with 5,000 or More Manufactural Employees.

York City constitutes the largest zone of factories in the United States. Over a dozen contiguous counties share in this development, ignoring the New Jersey-New York state boundary. Logically, this is one manufactural area, and, fortunately, is treated as such by the census in its metropolitan area tabulations. Obviously, when the statistics are tabulated by states, the Greater New York urban area is divided in two. The opposite is illustrated by the situation in Pennsylvania, where the Pittsburgh industrial area in the west is distinctly separate and different from the Philadelphia area in the east; yet both are blended in the state's statistics. The conclusion is that the locational pattern of an economic activity can be revealed through broad generalizations in terms of entire states or groups of states, but the inherent disadvantages call for a more refined pattern. The mapping of manufacturing by counties and metropolitan areas meets this need.[1]

[1] In most cases a standard metropolitan area consists of a single county or group of counties containing a large urban settlement.

Manufactural regions. The location of counties containing at least 5,000 employees in manufacturing reveals the dominance of manufacturing in northeastern United States (Map 2.1). Clearly this area contains the main manufacturing belt of the nation. When a line is drawn from Baltimore through central West Virginia, Louisville, St. Louis to Kansas City, northward to Minneapolis-St. Paul and eastward through central Wisconsin, Michigan, New York, and central New England, it encompasses nearly three-fourths of the nation's manufacturing (Map 2.2). Yet within this zone are broad expanses of nonindustrialized counties. Clearly, the term "belt" connotes a series of distinctly separated manufactural regions. The Northeast contains eight major manufacturing regions and several isolated centers of manufacturing.

A number of important manufacturing regions have developed outside the main manufacturing belt. In the South, major regions of manufacturing have arisen in the southern Piedmont and Gulf Coast areas. Concentrations of manufacturing have also developed



2.2. United States—Major Manufactural Regions.

in the Interior West at such places as Denver, Pueblo, Salt Lake City, Spokane, and Phoenix and on the Pacific Coast in the cities of Los Angeles-Long Beach, San Francisco-Oakland, San Diego, Portland, and Seattle. Outside of these major concentrations are many small scattered manufacturing centers. Certain areas are also essentially devoid of manufacturing. Of the eastern United States area, northern New England, the Adirondacks, the Blue Ridge and Great Smokies, parts of the Appalachian Plateau from southern New York to southern Tennessee, southern Illinois and northern Missouri, and western Iowa, exhibit little industrial activity.

New England

New England is the most highly industrialized portion of the United States. The six states which constitute New England—Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine—had 1,400,000 people employed in manufacturing in 1958. This represented 39.8 per cent of New England's total employment. None of the other eight census regions of the United States had such a large share of their labor force employed in manufacturing (Table 2.6).

New England has about 9 per cent of the nation's manufacturing, the total employment in United States industry being 16,046,945. Within New England the distribution of manufacturing is heavily concentrated in the southern portion.

TABLE 2.6

Employment in Manufacturing Expressed in Proportion to Total Employment—1958 (Excluding agriculture)

United States	31.5%
New England	39.8%
Middle Atlantic	36.2%
East North Central	38.7%
West North Central	19.3%
South Atlantic	28.3%
East South Central	30.3%
West South Central	19.6%
Mountain	13.8%
Pacific Coast	27.4%

Source: United States Census of Manufactures, U.S. Department of Commerce, Washington, D.C.

TABLE 2.7

Trends in New England's Manufacturing 1899-1958
(in thousands of employees)

	Total employees							
	1899	*1909*	*1919*	*1929*	*1939*	*1947*	*1954*	*1958*
NEW ENGLAND	894	1185	1506	1244	1119	1476	1448	1400
Massachusetts	463	633	801	639	549	719	685	678
Connecticut	168	230	332	288	281	400	420	396
Rhode Island	92	120	153	140	122	147	125	116
Maine	73	84	96	76	82	100	104	98
New Hampshire	69	82	88	71	61	75	77	79
Vermont	29	36	36	30	24	35	36	32

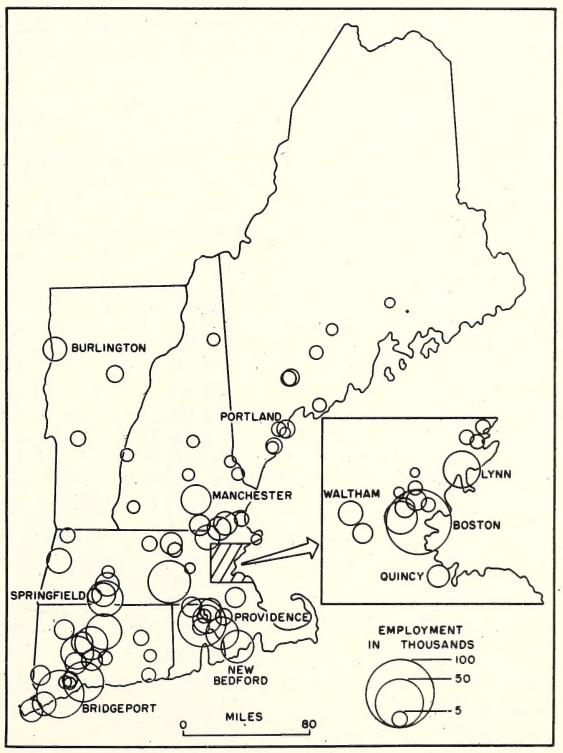
Source: United States Census of Manufactures, U.S. Department of Commerce, Washington, D.C.

The trend in New England's manufacturing, measured by total employment in manufacturing, is shown in Table 2.7. Industry grew steadily throughout the nineteenth century, reaching a peak in 1919 when the Census of Manufactures reported over one and a half million people engaged in manufacturing. However, during the 1920's New England's industry declined considerably in spite of the fact that the nation's industry as a whole was growing. The reason for this anomaly is basically the shrinking of the textile industry, which constituted the major portion of New England's manufacturing (48).

The depression of the 1930's caused the region's industry to decline still further, and recovery was exceedingly slow. In 1939 New England still had fewer people working in factories than it had in 1909. But the business stimulus of World War II generated a revival in New England's manufacturing. Factory jobs in 1947 almost equalled those of the 1919 peak.

Although the general employment trend was upward in absolute terms in New England from 1939 to 1947, it expanded at a slower rate than did other parts of the nation. Between 1939 and 1947, this region's 31 per cent rate of growth was considerably below the national rate of 48 per cent and was far outstripped by the Pacific Coast's 67 per cent. Between 1947 and 1958, employment in manufacturing in New England experienced an absolute decline of 76,000 workers, indicating that the region has not maintained the upward trend of the 1939-1947 period.

Leading industries. New England industry is diversified with secondary manufacturing being much more important than primary manufacturing. In 1958 no industry represented more than 27.5 per cent of total industrial employment, and no other industry had as much as 10 per cent of total employment. The three leading industries are textiles, machinery (including electrical), and leather (Maps 2.5, 2.13).



2.3. United States—Location of Manufacturing in New England.

Textiles. Textiles were New England's leading industry for decades. However, between 1947 and 1954 textiles lost their supremacy to the machinery industry. During this period employment in textile mills declined from one in five workers to one in ten workers. Textile production reached its peak in 1923 when the six New England states reported a total of 335,000 people employed in textile mills. Increasing competition from textile producers in the South began to retard New England's activity in the 1920's. The depression of the 1930's caused additional losses. The stimulus of World War II temporarily stemmed this decline, however. In fact, between 1939-1949 textiles showed a slight rise in employment, reflecting a gain in woolens which offset a loss in cottons. However, in the 1950's the decline once again became apparent, and in 1958 only 130,720 workers were employed in the production of textiles.

The emphasis in textile production originally was on cottons. In 1880 there were two and one-half times as many New Englanders making cotton goods as compared to woolens (Table 2.8). Cottons reached their peak employment of 211,118 in 1919 and have declined markedly since then; the 1958 employment being about one-quarter that of 1919. By contrast the woolen industry did not experience a marked decline until the 1950's. It surpassed the cotton industry in the mid-1930's and in 1947 was providing jobs for half again as many New Englanders as were cotton textile activities. The 1947 employment in woolens was not far below the 1923 peak. However, by 1958 woolen textiles employed only 42,000 workers.

As the cotton industry experienced difficulties, its management met southern competition by producing higher quality goods. Certain competitive advantages were conceded to manufacturers in the South, where labor costs, power costs, and other operating costs were less. For instance, the production of printed cloth practically disappeared in New England mills. Emphasis now in New England is upon high-grade cotton fabrics and upon those containing a mixture of cotton, rayon, and silk.

New England's textile industry is focused in two zones: (a) northern Rhode Island and adjacent Massachusetts, with major centers being Providence, Fall River, and New Bedford. This zone is the heart of New England's cotton textile manufacturing, but it also produces

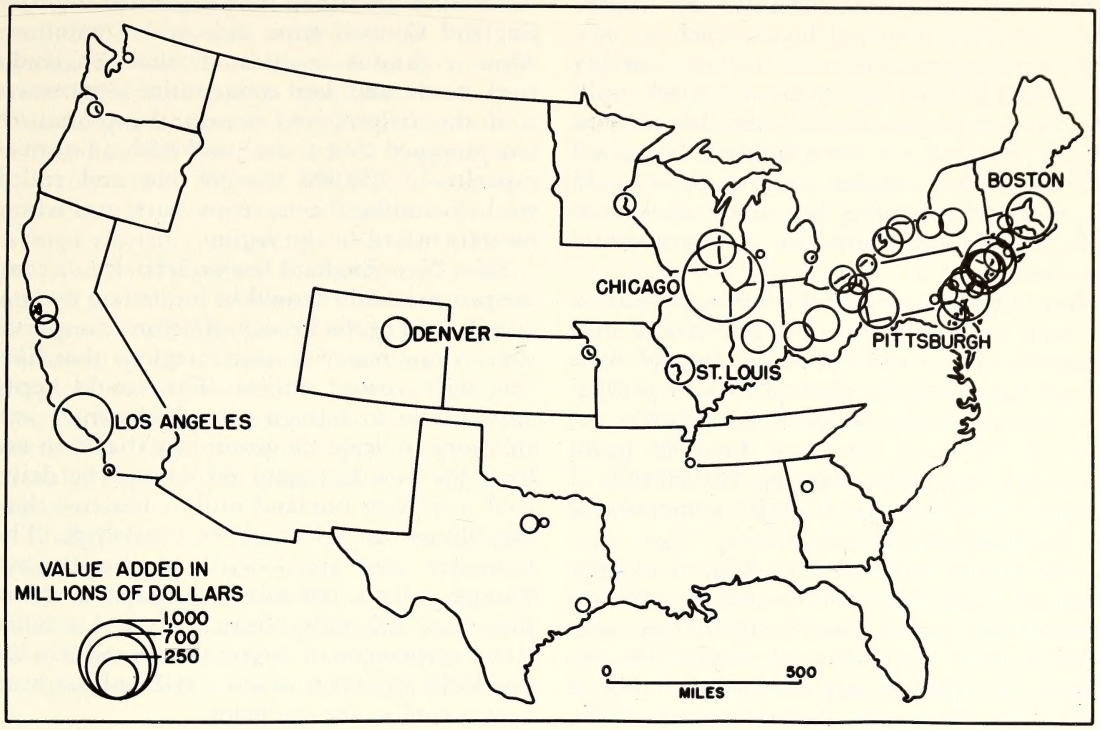
TABLE 2.8

Trends in Selected New England Industries

		Number of employees		
Year	*Cotton textiles*	*Woolen textiles*	*Shoes*	*Electrical machinery*
1880	125,779	47,932 *	—	123
1890	147,359	69,595 *	82,381 *	2,738 *
1899	164,933	75,391 *	85,259 *	7,121 *
1904	155,891	91,792 *	87,675 *	11,997 *
1909	189,701	107,660 *	104,485 *	19,806 *
1914	195,003	103,738 *	109,482 *	23,993 *
1919	211,118	110,799 *	116,491 *	37,230 *
1921	192,438 *	105,447 *	91,369 *	27,634 *
1923	208,725 *	124,858 *	102,484 *	42,841 *
1925	175,850	107,270 *	87,213 *	41,178 *
1927	166,661	103,691 *	86,473 *	40,943 *
1929	137,413	96,190 *	88,455 *	46,649 *
1931	98,891	78,781 *	78,304 *	28,854 *
1933	100,096	—	76,330 *	22,716 *
1935	88,287	108,517	83,933 *	30,874 *
1937	83,826 *	92,797 *	88,840 *	45,325 *
1939	77,152 *	94,540	90,780	35,486
1947	74,744	112,346	77,748	77,337
1954	69,434	45,659	80,192	120,847
1958	56,584	42,479	75,577	—

* Incomplete figure for industries and states for which statistics are withheld to avoid disclosure of individual establishments.

Source: United States Census of Manufactures, U.S. Department of Commerce, Washington, D.C.



2.4. United States—Electrical Machinery Industry—1958.

considerable woolens; and (b) the Merrimack Valley (Lawrence, Haverhill, and Lowell), which produces cotton textiles, but which is more widely known for woolen production.

Machinery. Machinery fabrication, including the production of electrical machinery, has become New England's leading type of manufacturing (Maps 2.4, 2.15). Between 1939-1958 the business was so brisk that employment in machinery factories increased by over 100 per cent. No other New England industry approached that rate of growth. The 285,984 workers which the machinery industry employed in 1958 ranks that industry far ahead of textiles. The relative importance of the machinery industry is greater in New England than it is in the United States as a whole. Machinery represents 27.5 per cent of New England's industry and about 15 per cent of the United States total.

Machinery is the leading industry in both Massachusetts and Connecticut. Major centers, along with the number of people employed in machinery factories, are: Boston (71,000), Hartford (24,000), Bridgeport (17,100), New Britain-Bristol (19,000), Springfield-Holyoke (18,100), and Providence (12,000).

The fabrication of other metal products is mainly in western Massachusetts and Connecticut. For years the distinction has been made between eastern New England, with its emphasis on textiles, and western New England, where fabricated metal goods are more typical.

Metal products typical of New England are those which require relatively large amounts of skilled labor and small quantities of raw materials. Typewriters, cutlery, textile machinery, radio equipment and machine tools are examples of these products.

Primary metals. Primary metals have never been a major industry in New England (Map 2.10). The region lacks ores of iron, copper, aluminum, and other industrial metals. Furthermore it has no coal to use in smelting ores. However, its metal fabricating industries do comprise a steadily increasing market for sheet steel, bar steel, and other steel products which

come from primary metal factories. No wonder then that New England businessmen are giving increasing consideration to the possibility of locating blast furnaces and steel mills within their region. They reason that the cost of shipping steel into New England from steel centers in other regions is greater than would be the cost for hauling raw materials such as coal, iron ore, and limestone to New England markets.

New England metal fabricators generate a demand for two to three million tons of steel annually. The nature of their demand is so varied that no single steel mill could provide the varieties of steel required; nevertheless, authorities estimate that New England could support a steel mill producing 840,000 tons of finished flat rolled steel in such common forms as sheets, strips, plates, and bars.

The freight rates on steel shipped to New England from the nation's steel centers are considerably higher than would be the rates from a New England steel center. For example, in 1950 the carload rate on a ton of steel from Pittsburgh, Pennsylvania to Hartford, Connecticut was $14.00. From Sparrows Point, Maryland it was $10.60. However, if New England had a steel mill at a seaboard location such as New London, Connecticut, the rate to Hartford would have been only $5.00 per ton (Table 2.9).

In order to investigate the possibilities of cheaper steel for New England, leading businessmen of the region have organized the New England Council Iron and Steel Committee. After a careful analysis of New England's steel needs and her comparative remoteness from the nation's steel centers, this committee has proposed that a steel mill with an annual capacity of 840,000 tons of hot and rolled steel—including sheets, strips, bars, and wire—be constructed in the region.

Since New England has no iron ore or coal, the proposed mill should be located on the seaboard, with access by way of ocean transportation to raw material source regions that likewise have coastal outlets. This would apply particularly to foreign ores. Preliminary calculations indicate the possibility that iron ore from the new Labrador mines may be delivered to a New England mill at less cost than Mesabi ore is delivered to Pittsburgh. The Labrador ores are located in the Ungava Trough, about 700 miles northeast of Montreal and 360 miles from the St. Lawrence River settlement of Seven Islands, which has ore docks and from which a railroad has been constructed to the ore fields.

The Labrador ores have an iron content of between 50 and 70 per cent, and most of the iron has tested above 60 per cent. These are richer than the present shipments from the Mesabi, where the ores are measuring a 51 per cent iron content.

A New England steel mill on the coast also would have access to recent developments of

TABLE 2.9

Transportation Costs on Ore and Coal Required Per Net Ton of Steel and on Finished Products for Selected Actual and Hypothetical Producing Locations Serving

HARTFORD

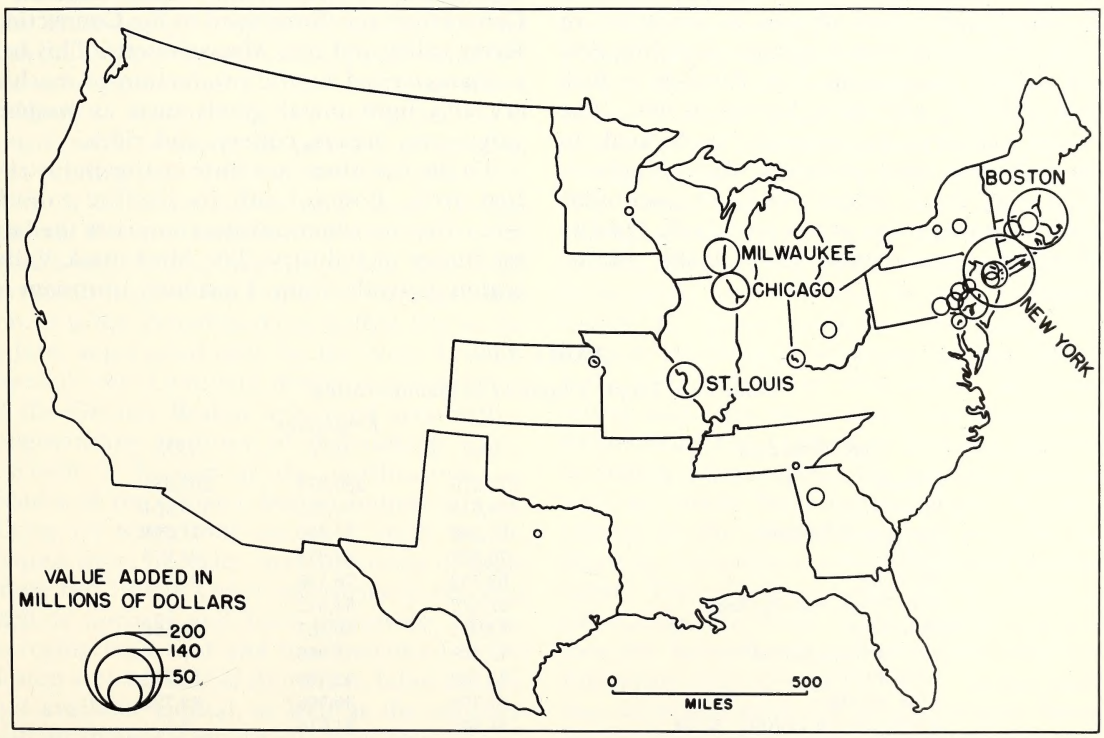
Location		*Transportation costs on: Ore*	*Coal*	*Finished products*	*Total*
Fall River	Labrador	$4.56	$6.01	$ 6.80	$17.37
	Venezuela	3.68	5.63	6.80	16.11
New London	Labrador	4.56	5.79	5.00	15.35
	Venezuela	3.68	5.42	5.00	14.10
Pittsburgh		5.55	1.56	14.00	21.11
Cleveland		3.16	3.85	14.40	21.41
Sparrows Point		4.73	4.26	10.60	19.55
Buffalo		3.16	4.27	12.20	19.63
Bethlehem		5.56	5.06	8.60	19.22
Trenton		3.68	4.65	8.40	16.73

Source: Economic Geography, Vol. 26, October 1950, p. 250.

iron ore in Venezuela. Coal likewise would be available via coastal waterways. It will cost more than would be the case in Pittsburgh; nevertheless authorities figure that coal from West Virginia mines can be shipped from Norfolk and be delivered at the New England mill at a cost which will not offset the lower iron ore costs. Moreover, trends indicate that increased efficiency in steel production is slowly but steadily decreasing the volume of coal required per ton of iron ore. Limestone can be procured from Rockland, Maine; Florence, Vermont; or New Canaan, Connecticut. Scrap iron and steel constitute an increasing proportion of the charge which goes into steel furnaces. New England has a surplus of scrap and actually exports this commodity to steelmaking centers.

With plenty of scrap metal at hand, with limestone within the region, with access via water transportation to iron ore and coal, and with a steadily increasing demand for steel, New England appears to some authorities as being ready for its own steel mill. However, certain economists feel that the giant mill constructed by U.S. steel near Trenton, New Jersey will provide New England with steel as economically as could a small mill located in New England. In their analysis of the problem, Isard and Cumberland conclude that "a New England operation based on Labrador or Venezuela ores would enjoy definite transport cost savings over existing operations in serving the New England market. However, the advantage over the site at Trenton disappears as one approaches the southern New England area. Other costs of production are not unfavorable for New England, and there may be some slight advantage as regards the price of scrap" (51).

Leather. The leather industry employs approximately 106,000 people in New England and ranks considerably behind textiles and machinery as the third largest activity in the region's industrial structure (Map 2.5). However, New England occupies a very conspicuous position in the nation's leather industry, since about 30 per cent of American leather



2.5. United States—Leather and Leather Products Industry—1958.

and leather goods is made in these six states. New Hampshire's leading industry, in fact, is leather production. In no other industry does New England possess such a large proportion of the national activity. By comparison, her share of the national textile industry in 1958 was only 15 per cent.

Primary processing of hides and skins is done in many small cities as well as the major centers of Boston, Haverhill, Brockton, and Lynn. Boston is a leading receiving port for foreign hides and skins. Secondary manufacturing of leather products consists mainly of footwear, and for years New England was the nation's leading shoemaking region. However, this industry, like textiles, has been leaving New England in order to be located more centrally in respect to the American market and especially to the meat-packing industry from which comes most of its raw hides and skins. Location of the industry is in the larger cities (as well as many of the small cities) of eastern Massachusetts, New Hampshire, and Maine.

Other industries. A number of other industries are important in the New England industrial structure. A wide range of apparel such as shirts and cotton dresses is produced in cities of southern New England, including Boston (25,000 employees), Fall River-New Bedford (10,000), and New Haven (4,400). The paper industry, by contrast, is located in Massachusetts and northern New England. Pulp mills are in Maine, while Massachusetts mills consume scrap paper and cloth. Quality paper is manufactured in Holyoke, Massachusetts.

Although of small extent compared to other industries in the region, New England's rubber and instrument industries occupy a conspicuous position from the national viewpoint. One-sixth of the nation's rubber industry is here, with the emphasis being upon footwear, raincoats, and apparel. A similar proportion of instruments such as thermometers, scales, and optical equipment is made in New England.

Leading industrial areas. Southern New England is industrial New England (Map 2.3). In 1958, New England factories employed 1,400,000 people, of which 85 per cent were in the three states of Massachusetts (678,000), Connecticut (394,000), and Rhode Island (116,000). Moreover, these are the three most intensely industrialized states in the nation. The United States has about 30 per cent of its labor force engaged in manufacturing, but in Connecticut the proportion is 46 per cent, Rhode Island 43 per cent, and Massachusetts 37 per cent. Southern New England is the most industrialized portion of the country.

Manufacturing is not distributed evenly over southern New England. A western belt extends from the southwestern corner of Connecticut northwestward to the Connecticut River valley and into Massachusetts. This belt is characterized by the production of machinery and light metal goods such as washers, valve caps, meters, cutlery, and rifles.

To the east there are three major industrialized areas. Boston, with its satellite suburbs and tributary communities, comprises the largest cluster of industry. The Merrimack Valley region extends from Lawrence upstream to

TABLE 2.10

Number of People Employed in Manufacturing

Industrial area	*Employees*		
	1947	*1954*	*1958*
Boston	271,275	280,274	298,085
Providence	154,613	130,825	128,534
Springfield-Holyoke	81,598	74,350	71,631
Bridgeport	70,127	64,873	64,973
Hartford	63,792	76,146	87,115
Fall River-New Bedford	62,572	54,842	—
Worcester	53,251	50,197	50,593
New Britain-Bristol	45,708	43,950	—
Waterbury	43,388	42,186	37,235
New Haven	41,503	46,566	42,725
Hillsborough County, N. H.	31,845	31,616	—

Source: United States Census of Manufactures, U. S. Department of Commerce, Washington, D. C.

Manchester. The area from Providence to New Bedford comprises a third zone. In general, these three eastern agglomerations of factory enterprises are characterized by textile-machinery-shoe production.

Eastern New England. The Boston industrial area is New England's leading concentration of industry (Table 2.10). Extending from Salem on the north to Waltham on the west and Quincy on the south, this area has 298,000 people employed in factories.

Secondary metal industries have become the largest component of Boston's industrial structure. Over 109,000 people—36 per cent of those working in factories—are drawing pay checks from metal fabricators. Machinery accounts for most of this, with electrical machinery alone employing over 42,000 people. Shipbuilding is a type of metal goods industry and is represented by the yards in Quincy. Employment here fluctuates sharply in response to national defense needs. A wide line of fabricated metal products such as cutlery, hand tools, and hardware constitutes another phase of Boston's metal industry.

Boston is noted for its production of leather. The 22,500 people engaged in this activity are distributed in both the primary and secondary phases of production. In contrast to her metal industries, Boston's leather industries do a considerable amount of primary processing, e.g., tanning and finishing leather. Moreover, there is a heavy dependency upon foreign sources for raw materials. Hides and skins from South Africa, Argentina, and the Mediterranean region are imported through Boston. It is the second-ranking leather city in the nation, superseded only by the New York industrial area. Lynn and Brockton are satellites of the Greater Boston urbanized area with a long-standing tradition of shoemaking.

Salem is located at the northeastern extremity of the Greater Boston industrial area. Along its waterfront are such mills as the Pequot sheet factories, manufacturers of high-grade bed linens. Other industries in the area include apparel and food processing. Manufacturing took root and has flourished in the Boston area because of its market, labor supply, and available capital, as well as the commercial advantages it enjoys as a port city.

The Providence-New Bedford region is smaller than the Boston area. It is the stronghold of New England's textile industry. Extending from Woonsocket on the northwest to New Bedford in the southeast, and including Pawtucket, Providence, and Fall River, this belt contains a textile development employing 40,000 people. The Providence industrial area alone (which includes Woonsocket and Pawtucket) has more than 25,000 of these workers, who constitute nearly 20 per cent of the total employment in the Providence area factories. Here there is nearly equal emphasis upon woolen textiles and cotton textiles. The Fall River-New Bedford area on the other hand has less textile employment (20,000 people), but these people represent about one-third of the area's total industrial manpower. Nowhere else in New England is the emphasis so strongly placed upon textiles. Moreover, this emphasis is almost entirely upon cotton textiles. For decades Fall River was the capital of America's cotton textile industry, and it still occupies the leading position in New England.

The first cotton mills in Fall River were established in 1813. Entrepreneurs looking for a place to launch these operations found in Fall River's location the coincidence of water power (falls in the Quequechan and Watuppa rivers) and a tidewater location permitting access to ocean trade in cotton and cotton goods. During the ensuing century Fall River's textile industry enjoyed a healthy growth. By 1875 there were 42 cotton mills employing 14,000 of the city's 16,000 industrial wage earners. The leading product was print cloth. Subsequent to 1850 the industry's growth raised its power requirements above the amount available from water power. Therefore, later expansion was based on steam power and took place along the waterfront, where Fall River's tidewater location was now becoming advantageous for receiving coal as well as cotton from ocean vessels. Another change in the post-1850 period was the increasing dependence upon imported foreign labor. The rapidly-growing textile industry, exhausting the local labor supply, reached into the hinterlands and then into southern European countries for workers. Large numbers of people migrated from Portugal. Housing projects often were constructed in the vicinity of the factories. For example, there is

today a block of old three-story apartment houses across the street from the Berkshire Mills, now the leading textile mills in Fall River. People of Portuguese extraction compose a conspicuous element in this block, and one hears Portuguese spoken by boys in neighborhood sandlot ball games. Most of the second and third generation Portuguese are bilingual, but many of the "old timers" who came from Portugal to work in the mills have not mastered the new tongue.

In recent decades the textile industry has experienced periods of stress and has declined. Vigorous competition from younger textile companies in the South has been the major factor. It was in 1880 that modern textile manufacturing took root in the Piedmont. In response to such favorable factors as lower labor costs and less taxation, the textile industry competed successfully with that in New England. Concentrating at first on coarser textile products, the southern mills gradually upgraded their product, and by 1909 were producing over one-third of the nation's print cloth. Until this time New England's textile industry had been growing slowly, but the South's had been growing more rapidly. By the second decade of this century it appeared that textile production in New England would soon decline. Increased demands associated with World War I granted New England's textile mills a reprieve of a few years, and activity rose to establish all-time records. However, the period of prosperity terminated in 1922, and decline set in. The recession was especially severe in the cotton textile mills, where nearly one-third of the employees were laid off. In 1924, two mills announced they were transferring operation from Fall River to a southern state. Others followed. By 1932 Fall River had only half the spindleage it had ten years earlier. By 1940 this proportion had declined to one-fourth. Increased demands, developed during World War II, temporarily halted the decline, but since World War II, the downward trend has continued.

Many buildings formerly occupied by textile mills in this region are now housing other types of industry such as clothing or rubber products, but other former textile mills are standing idle. Some of them, deserted by their owners and shackled with delinquent taxes, have been abandoned. For want of protection they have been raided by vandals, who either removed or destroyed every window sash, casement, door, and other usable accessory. One particular mill in Fall River stands silently as a gaunt spectre of deterioration, with every window and door opening stripped, a reminder of former days when Fall River was America's cotton textile capital.

Activity in New England's woolen textiles has not declined as greatly as that of cottons. Production of woolens is not so easily mechanized as is that of cottons. For instance, patterns can be stamped or printed onto cotton cloth, but they must be woven into woolens. Hence the greater relative importance of experienced skilled labor in woolen textiles. Moreover, the advantages of proximity to raw materials enjoyed by southern cotton mills is not shared by southern woolen mills. Again, the major market for woolens is the apparel market, highly concentrated in New York City, Philadelphia, and Chicago. New England is better situated in respect to these markets than is the South.

In addition to textiles, mention should be made of three other industries in the Providence-New Bedford region: jewelry, machinery and apparel. Providence is the jewelry and silverware capital of the country, with 25,000 people employed in producing these goods. Providence has 20,000 people making machinery: textile machinery, machine tools, and electrical machinery. The manufacture of apparel, men's shirts and women's cotton dresses, is important in Fall River and New Bedford.

Industry got its start and continued to thrive in this region because of the water-power resource, adept labor, and local capital accumulated from the commercial and fishing businesses of these cities.

The Merrimack Valley is the smallest of the three industrial regions in eastern New England. Approximately 100,000 people are employed in the factories of Manchester, Nashua, Lowell, Lawrence, Haverhill, and smaller cities in this valley. Most typical industries are textiles and leather; woolens are much more important than cotton goods.

Although Lowell is the largest city, it does not have the most manufacturing. That honor goes to Lawrence, where approximately

36,000 people are employed in factory operations. In Lawrence the ratio of factory employment to population is 1:2.8. In Lowell the ratio between the 21,500 industrial employees and the city's population is 1:6. Lawrence is primarily a woolen textile city. In the early 1800's that industry took root on the water-power sites of the Merrimack River in much the same manner as did textile factories on the Quequechan in Fall River. Lowell is a textile center, while Haverhill's leading product is shoes. Nashua and Manchester, in the New Hampshire portion of the Merrimack Valley, are textile and leather goods producers, with the emphasis on cotton textiles and shoes. Nashua has undergone severe economic strain with the collapse of its textile industry. The experience of Textron Incorporated illustrates the seriousness of the situation. This company operated mills in several New England communities, but discovered that production costs were less in the South and consequently began to establish factories in southern states. Rising costs in its New England mills gradually cut the margin of profit, and in 1947 Textron closed one of its smaller mills in Nashua, which employed 800 people. A few months later the company ceased operations in its Manville, Rhode Island cotton mill. In September of 1948 the company concluded it would have to terminate operations in its main Nashua mills, which employed 3,500 people. This represented nearly 35 per cent of Nashua's industrial payroll. Community officials, working with the company, faced the tremendous problem of finding places in the city's economic structure for the city's jobless.

The Worcester industrial area is transitional between eastern and western New England in both location and typical industries. It is forty miles east of the Connecticut River valley. With over half of its industrial employment in metal industries, 6 per cent in textiles, and 6 per cent in leather, it likewise is intermediate between the eastern type of development, where the percentage in textiles runs as high as 40 per cent, and the Connecticut Valley type, where the percentage in metals is about 66 per cent.

Worcester is conspicuous on a map of New England industry (Map 2.3) because its 50,500 factory employees are detached from surrounding industrial areas. Of the metal industries, machinery is the leader. A few woolen mills exist somewhat as outliers of the large textile industry to the east.

Approximately 50 per cent of New England's manufacturing is clustered in eastern Massachusetts, Rhode Island, and adjacent portions of New Hampshire. This was originally noted as a textile region of cotton and woolen mills but metal goods are now the most important, with leather goods following in third place.

Western New England. In western New England the main industrial belt extends from the southwestern corner of Connecticut for a distance of about 100 miles northeastward to Holyoke, Massachusetts. Approximately 400,000 people draw pay-checks from factories, most of which are clustered in six centers: (from north to south) Springfield-Holyoke, Hartford, New Britain, Waterbury, New Haven, and Bridgeport.

There is a much greater emphasis upon metal goods in this region than there is upon textiles in eastern New England. The most "textilized" area—Fall River-New Bedford—has only 33 per cent of its industrial employment in textile mills. For this western region as a whole the proportionate employment making metal goods is 66 per cent. A maximum of over 90 per cent in metal goods factories is reached in the New Britain area. It is the secondary fabrication of machine tools, hardware, cutlery, wirework, screws, and bolts that distinguishes Connecticut and western Massachusetts. Primary metal industries are inconspicuous. This situation has stimulated the growing demand in New England for the establishment of local primary metal factories to feed the secondary fabricators, who now are dependent upon steel mills in Pennsylvania, Ohio, and Maryland.

Springfield-Holyoke, located at the northern extremity of this industrial belt, is not only the largest urbanized area but also the largest industrial center. With about 71,600 people working in its factories it contains more manufacturing than any of the centers to the east except Boston and Providence. Along with New Haven, this area has the most diversified industrial structure in western New

England. Although metal goods are the leading products they do not exceed the national average. Machinery is the major item. Textiles are declining in importance, representing at the moment less than 6 per cent of the industrial employment. Nowhere else in this region are textiles of much significance. The second ranking industry is paper, which comprises 10 per cent of Springfield-Holyoke manufacturing. The emphasis is upon secondary manufacturing of high-grade stationery as well as printing papers made from such raw materials as rags and waste paper. Paper mills line the Connecticut River in Holyoke, but there are no rafts of logs in the river or stockpiles near the factories. The primary paper industry is not represented. Springfield-Holyoke is not only one of the most vigorous industrial centers in Massachusetts but also in western New England. The cities have an air of aggressiveness which distinguishes them from less rapidly growing centers to the east.

Thirty miles south of Springfield is Hartford, widely known as a commercial city and home of many insurance companies. But Hartford also is an industrial city. Metal fabrication is predominant, as three out of every four persons in industry are producing metal goods. Machinery, especially machine tools and electrical equipment, ranks first but is closely followed by production of aircraft parts. With nearly 12,000 workers, Hartford is the focus of the New England aircraft industry. The lack of industrial diversity, with the corresponding emphasis on metal goods, makes Hartford a typical manufacturing city of this region.

New Britain-Bristol, located only a few miles southwest of Hartford, is considered to be one industrial area. Although smaller in terms of population it constitutes the most intensely industrialized zone in western New England. Of the people employed in all economic activities, about half are in manufacturing. No other large community in New England approximates this proportion. Even more distinctive is the dominance of metal trades. The 36,000 people employed in metal goods factories comprise an astonishing 90 per cent of the total number of people working in all factories. Nowhere else in New England—and only in a few places in the entire nation—is a single type of industry so conspicuously present in one area. Distinctive products of New Britain-Bristol factories are machinery and hardware. This is the ball bearing and roller bearing capital of the United States. It also is a leading producer of cutlery, handtools, and hardware. One can enter a hardware store in almost every city of the nation and find numerous items on display bearing the mark "New Britain, Connecticut."

Waterbury, a city of 150,000 people, is located on the Naugatuck River less than 20 miles from Bristol. With over 37,000 people engaged in manufacturing it is another highly industrialized city. Again metals far exceed other industries. Two out of every three people working in factories are fabricating metal goods. However, there are two types of metal industries which distinguish this city. It is the heart of New England's copper manufacture, as well as being important in the manufacture of instruments.

New Haven, located on Long Island Sound, has the smallest amount of industry and is also the least industrialized of the six leading communities in western New England. Moreover, metal industries are less significant here. Collectively, the various categories of metal goods production comprise 40 per cent of the city's total; but none of them alone is as large as the apparel industry. Men's shirts and pajamas and women's dresses are major products of the New Haven mills.

Bridgeport has more manufacturing than any center in this region except Springfield-Holyoke. With metals comprising 72 per cent of its industry it has the same lack of diversity that typifies Hartford, New Britain, and Waterbury. However, no single metal product is predominant.

The industrial belt which extends from south to north through Connecticut and the adjacent portion of Massachusetts contains over one-third of New England's manufacturing. It is conspicuously different from other industrial areas of New England in two respects: (a) The predominant type of industry is the secondary fabrication of metal goods, such as machinery, hardware, airplane parts, and instruments, and (b) industry is experiencing a vigorous growth, nearly three times as rapid as the rate prevailing in eastern New

England and considerably ahead of that for the nation as a whole. In fact, the expansion of industry here compares favorably with that in many sections of the South.

Industry in other areas. Detached from the areas already discussed and widely dispersed over the rest of New England are several small industrial centers. Near the western border of Massachusetts is Pittsfield, where 14,000 people work in factories producing electrical machinery, broad-woven cotton fabrics and woolens. Lewiston is Maine's leading manufacturing city (13,000 people in factories). Burlington (Vermont), Berlin (New Hampshire), and Waterville and Bangor (Maine) are outposts of industry marking the northern boundary of the New England industrial region. To be sure, a few factories exist further to the north, but none employ a very large number of people and no northern community has as many as 1,000 people in factory occupations. Most of the manufacturing in Vermont, northern New Hampshire, and Maine is quite different from that in southern New England, where factories feed upon raw materials from other regions and transform them into products destined for market in other regions. For example, iron and steel are brought in; machinery and hardware are shipped out. Cotton and wool are brought in; textiles are shipped out. But in northern New England the outbound products originate as local raw materials. Paper and timber from the surrounding pulpwood stands, stone from local quarries, and canned goods represent the "fruits, vegetables, and fish" of the local resources. Inbound raw materials for the most part are made into products for the surrounding market. In a region where population is not growing rapidly, industry in northern New England is barely holding its own. Originally, this area thrived when the wood-using industries boomed because of the abundance of local timber and water power. Now, the timber has been depleted, and this has become one of the most seriously "cut-over" portions of the United States. Manufacturing has reacted directly to this depletion by showing consistent declines. World War II stimulated business enough to arrest this trend somewhat but future development will depend on the ability of forest managers to provide a regular crop of pulpwood for paper mills, and upon any new technological developments which will utilize the region's water power.

Relationships between manufacturing and other features. There are several associations which can be observed not only between manufacturing and other features in New England but also between New England manufacturing and other regions of the United States and the world.

Raw materials. New England's manufacturing is tied closely to other regions by its need for raw materials. The textile industry, which constituted the bulk of manufacturing for over a century, has been bound to other states and to foreign nations for all its raw cotton and almost all of the wool which feeds the mills. Similarly the metal industry has been dependent on other regions. New England has some iron ore but the local resource is so inadequate that it satisfies scarcely any of New England's needs. Likewise New England's leather industry depends on outside sources.

In fact, New England today is deficient in all but one of the four major activities producing raw materials for manufacturing: mining, lumbering, agriculture, and fishing. She never has had much mineral endowment. Coal, iron ore, and copper must all be brought in from elsewhere. Originally her timber stands supported an industrial development, but those stands are gone. The stony soil of New England makes it, on the whole, a comparatively poor agricultural area. There is not sufficient agricultural production here to provide local raw materials for flour mills, meat-packing plants, tanneries, or cotton and woolen mills. Canneries are the one type of industry based upon local crops. Fishing is the one local activity producing a significant raw material base for New England manufacturing.

Power. Today New England's industry is dependent on other sources for most of its power. Of the 5,268,000 kilowatt generating capacity in New England, 77 per cent is steam and 23 per cent hydroelectric. Three-fourths of its requirements depend upon coal, petroleum, and gas, all of which must be imported. Most of the coal from Pennsylvania comes by rail, while that from West Virginia moves by boat from the ports on Hampton

Roads, Virginia. Petroleum comes by tanker from Texas Gulf ports and from foreign sources. The nation's natural gas pipeline network now extends into New England. In 1950 the Federal Power Commission granted permission to two large U.S. utility firms to penetrate New England with their pipelines. The Tennessee Gas Transmission Company has constructed a 529-mile system leading eastward from its Texas-Buffalo line. Likewise the Texas Eastern Transmission Corporation has formed a subsidiary to deliver natural gas to New England, where lack of natural gas had been one factor keeping industrial costs high.[2] However, in the early days of its industrial development New England had one important power source: water. It was along the falls, rapids, and dams of New England streams that factories were rooted. Numerous communities—even some very small ones had their dam, or dams, which were flanked by a pair or more of factories. With the advent of steam, followed by thermoelectric power, it became more economical, for the smaller mills especially, to purchase power from larger, centralized power companies. Yet even today many New England communities have a dam across a stream and a factory or two alongside.

Markets. New England has a population of 10,423,000, enough people to constitute a sizable market for factory output. Moreover, the population is increasing. The 1960 Census of Population shows a gain of 11.7 per cent for the preceding decade. Although this was behind the national rate of 17.5 per cent it was ahead of the East South Central states (4 per cent) and West North Central states (8 per cent). Through the years the local market has played a part in supporting New England manufacturing. But as factories developed, their salesmen began cultivating markets in an increasing number of other regions. No study has ever been made of the proportion of New England's industrial output going to foreign markets. However, the Connecticut Development Commission estimated in 1960 that about 15 per cent of that state's factory employment was dependent upon foreign markets.

[2] In 1957, 89,966 million cubic feet of natural gas was marketed in New England.

Labor. A productive, skilled labor force is the foundation upon which New England industry rests. Most of the raw materials and fuel comes from other regions; most of industry's production is shipped out to other regions. But a productive labor supply has been abundant in New England since the nineteenth century. As long as the factories were supervised efficiently and as long as labor produced at its maximum capacity, New England industry thrived. Only with obsolescence of machinery and reduction of working effort did New England fail to adjust successfully to labor competition from other regions. In view of the high degree of skill possessed by New England's labor force, it has been possible through the years to upgrade the quality of product as regions with lower labor costs cornered the market for more cheaply made goods.

The wage differential between New England and its major regional competitor, the South, has been diminishing steadily. The Council of Economic Advisers to the President, in their report of July 1951 (*The New England Economy*) stated: "As the South's industrial expansion proceeds and as its people migrate to richer areas, the wage advantage of the South is gradually diminishing. The narrowing of the wage differential is significant. Unless the differences in productivity between the North and South change in favor of the South more rapidly than the wage differential narrows, this narrowing of the wage differential means a lessening of the net advantage of many industries in the South."

At times in the past there has been a great inflow of labor to New England, especially from Europe. Conversely there has been an outflow of labor, especially supervisors and skilled production workers, as New England textile mills and shoe companies left the region to establish operations elsewhere in the United States.

New England is one region in the United States with a surplus of labor. Statistics compiled by the United States Department of Labor reveal that every single industrial center in eastern New England has manpower available for employment. By contrast, western New England does not have such a surplus. In fact, Hartford has a definite shortage, while

in Bridgeport, New Haven, and New Britain the demand for and supply of labor are balanced. Only Springfield-Holyoke has a surplus.

Capital. Although poor in natural resources for manufacturing, New England early possessed monetary resources for establishing industry. Profits from fishing, lumbering, and shipping constituted a reserve of capital in the hands of New Englanders, who readily invested it in manufacturing. This was especially true since the region's agricultural resources were inadequate to sustain a regional economy based on crops and livestock. The timber resource was basic to the shipbuilding industry that produced fishing vessels in which New England fishermen brought home the catches, which, when sold, brought millions of dollars of capital to Yankee accounts. Moreover, the timber resource was basic to the construction of merchant ships which carried the ocean commerce of not only the United States but other nations as well, thereby accumulating more capital for New England entrepreneurs. Thus, when the Industrial Revolution developed, New England businessmen had a supply of money to invest in factories and machines—the inanimate components of the new regime.

Industrial genius. The industrial development of New England cannot be understood without considering the role of inventive genius and diligent management. Countless new ideas and devices have been conceived by New Englanders for the manufacture of new products or the improvement of established processes.

Transportation. In the early days of the Industrial Revolution, the sea was America's "main street" as well as a highway to foreign lands. New England fronted on the sea and, with numerous port cities, enjoyed access to the best transportation of the times. One of the advantages which made Fall River and New Bedford outstanding industrial cities of the 1800's was their location on the sea lanes, which gave their textile mills an advantage over those in inland cities in terms of access to New York and other Atlantic Coast markets. It took less time to ship a load of textiles by sea from Fall River to New York than by land from interior New England cities. Likewise, New England as a whole enjoyed a transportational advantage over the rest of the United States because of its proximity to European markets.

However, when American transportation moved into the canal era in the early 1800's, New England was handicapped, especially as regards access to the newly opened interior of the continent. This disadvantage is illustrated by the rapidity with which New York City overtook Boston as the nation's leading port. The Berkshire Mountains east of the Hudson-Champlain lowlands, barricaded New England from interior United States and blocked Boston's access to the promising new territory. By contrast, New York City was blessed with easy access via the Hudson and Mohawk valleys. With the construction of the Erie Canal, New York's clearcut advantage over Boston was established.

In the railroad era, New England's factories have been nourished by a circulatory system involving several railroads, of which the New York, New Haven and Hartford is today the most important. This organization serves Connecticut, Rhode Island, and Massachusetts with a network which threads its way into nearly every major industrial center of New England. Boston and New York City are the two main terminal cities of the New Haven system. A second railroad, the Boston and Albany, provides a western outlet for Boston and other Massachusetts cities. It is a subsidiary of the New York Central Railroad. Of lesser importance to New England manufacturing as a whole are the Boston and Maine, Vermont Central, and Maine Central railroads. New England railroads depend heavily upon manufacturing for their pay loads. Factories provide about 60 per cent of the tonnage originated and 40 per cent of the tonnage terminated by New England railroads. The national averages are about 25 per cent and 30 per cent respectively. In no other region is there such a strong association between railroads and factories as in New England.

With the advent of good roads and improved trucking, New England factories have come to depend upon this mode of transportation for the shipment of most of their finished products and a considerable, though lesser, share of their raw materials. Indeed, one

reason why New England railroads have suffered so much financial distress in recent decades is that truck competition has taken over so many shipments for New England factories. The typical product of the region's manufacturing is small, light, and of high value, representing considerable skilled labor in proportion to weight. It is precisely such products that trucks are especially adapted to carry. Consequently, the typical scene in New England is that of loaded cars moving in with raw materials for factories and empty cars moving out—the products of the factories going by truck.

An early start. On the basis of its local market, inventive genius, productive labor, water power, timber, capital, and early transportation assets, New England proved a fertile land in which factories could take root in the early 1800's. In that period no other region of the United States possessed as large a combination of so many industrial bases as did New England. It quickly became the manufacturing heart of a nation which, in its other portions, was primarily agricultural.

But the passage of time diminished several of New England's advantages; indeed, some disappeared. Settlement of the new nation caused the center of population to move steadily westward, leaving New England increasingly far from the nation's markets and intensifying its locational handicap in comparison with newer industrial regions to the west. New England's industrial labor as a whole was organized before that of other regions. Consequently, she experienced an increase in labor costs in competition with nonorganized regions. The advantage inherent in having numerous small water-power sites declined and disappeared in many places, as large thermoelectric power factories appeared on the industrial scene to provide a regular flow of cheap, mass-produced, electric current. New England's timber was seriously cut-over and declined sharply in importance as a base for the region's economy. Transportation advantages were offset considerably during the canal era. The combination of (a) the Industrial Revolution, in which coal and iron played such an important role, and (b) the westward growth of the United States, brought into bold relief New England's two major industrial handicaps: lack of minerals and a comparatively remote location in respect to the national market.

In time, New England's only outstanding industrial advantages were the fruits of its early start in manufacturing; namely a reservoir of skilled labor, an experienced management, and a supply of capital. On the momentum of its early start, manufacturing has persisted in New England in a manner out of proportion to the region's population or present endowment, especially since every passing year finds New England, located in the northeastern corner of the nation, progressively farther away from the heart of the American market.

Problems of New England industry. Since 1919 the decline of New England's major industry—textiles—has been the region's severest industrial problem. Concomitantly, the leather industry has declined. New England's dependence upon these industries as the two cornerstones of her industrial structure left her vulnerable to the type of change which the nation's economy experienced. In recent decades American industry has shown spectacular expansion in producer goods, especially machinery, and comparatively little expansion in consumer goods of the nondurable type, especially textiles and leather, which in 1919 represented 40 per cent of New England's manufactural employment. As the nation's industry continues this metamorphosis, New England must adapt her industry in order to achieve optimum integration with the program of the national and world economy. New England must develop new industries in which her reservoir of skilled labor can perform. The problem is intensified by the handicap of tradition, and New England is the oldest industrial portion of the nation; changing old practices is more difficult than establishing new ones.

In making this ajdustment, New England's manufacturing faces three handicaps, all of which are reflected in high costs. The first of these handicaps is the high transportation cost involved in assembling materials. The second is the high transportation cost involved in reaching the market. The third is the high production cost connected with the actual fabrication of products.

Transportation costs in assembling materials

are high because the materials much be transported considerable distances. Two types of materials in particular must be brought from distant regions: resources and steel. New England is poorly endowed in natural resources, and her coal, petroleum, and ores must be brought in from distant places. New England also lacks a primary steel industry which means that her rapidly growing fabricators of steel goods must be fed by steel transported from Sparrows Point, Bethlehem, Morrisville, Pittsburgh, Youngstown, or Buffalo. "Cheaper steel for New England" is the slogan of the region's rapidly growing steel users.

Transportation costs in placing products on the United States market are comparatively high because the westward shift of the population center is leaving New England increasingly farther away from the national market—which probably receives 90 per cent of New England's industrial output. By specializing in goods which have a high value in proportion to weight (shipping cost) New England is endeavoring to overcome this locational handicap.

A corollary of handicaps one and two is the high transportation costs on finished products destined for the domestic market. The increasing emphasis on metal goods finds New England factories drawing more and more steel from steel producers to the west and shipping more and more fabricated steel products west. The resulting backhaul involves more transportation costs than accrue for competitors located in Pennsylvania, New York, and Ohio.

Production costs are high in New England because of four factors:

(a) Labor costs are high in some industries. In 1960, wages in the United States were 38 per cent of value added by manufacture; in New England they were 42 per cent. This does not necessarily mean that the cost of labor per unit of production was higher but that the emphasis was upon goods requiring more human effort. However, studies of labor costs indicate that the unfavorable differential between New England and the South is declining and that already New England can offer savings in labor costs in comparison with many Midwest and Western areas.

(b) Taxes are high. The Council of Economic Advisers in their July 1951 report concluded their discussion of the tax burden by saying: "The net burden of both state and local taxes is somewhat greater in New England than in its industrial competitors."

(c) Power costs are high. The average cost of purchased power per kilowatt hour in 1960 averaged $1.70 in New England, $1.45 in New Jersey, $1.31 in Michigan, $1.21 in Ohio, $1.20 in Pennsylvania, 95 cents in North Carolina, and 63 cents in Tennessee.

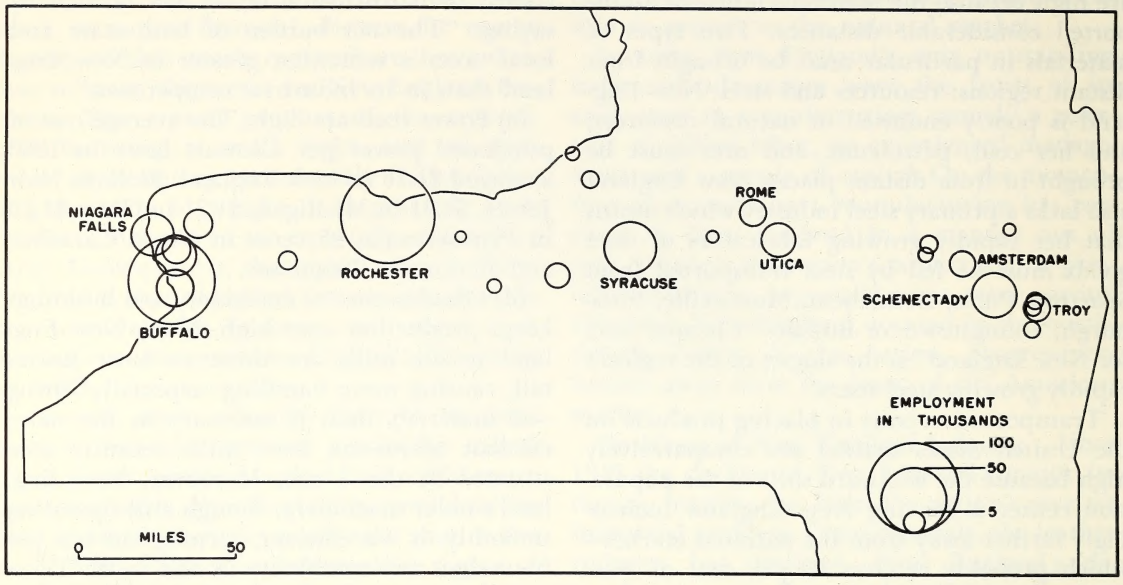
(d) Obsolescence of machinery and buildings keeps production costs high. Many New England textile mills are three or more stories tall, causing more handling—especially lifting—of materials than is necessary in the more efficient all-on-one floor mills recently constructed in the South. Moreover, New England's older machinery, though still operating smoothly, is less efficient, turning out less per hour than new machinery in new mills. These new mills do not have capital already invested in old machinery and hence were free to invest in new. In spite of these handicaps the Council of Economic Advisers concluded that "no one of these disadvantages is large and that in some cases corrective tendencies have been set up.... But the cumulative effect of these disadvantages has undoubtedly been a deterrent to employment in some industries. ... Most of these disadvantages can be removed, or at least their effects can be reduced."

The future of New England industry depends upon the ability of management and labor to adapt themselves to a changing situation in which they face several handicaps.

Central New York Region

Extending over 300 miles from the Tri-Cities on the east near the New England border (Albany, Troy, Schenectady) to the western edge of New York is a belt of manufacturing which is of geographical interest not so much because of the amount of industry but because it illustrates a particular type of locational pattern. This industrial belt is not continuous but is made up of isolated manufacturing centers.

Pattern. Northern New York state is almost devoid of manufacturing. The same can be said for much of southeastern New York. Separating these two "blank" areas on the



2.6. United States—Location of Manufacturing in Central New York.

manufacturing map is a narrow ribbon of industrialization (Map 2.6). This ribbon is the only belt of manufacturing extending from the eastern seaboard to the interior. Students familiar with the physiography of the United States will recognize this as the Mohawk Valley, the only east-west penetration of the Appalachian Highlands. These Highlands extend from eastern Canada, northern New England, and northern New York (Adirondack Mountains) through southern New York (Catskill Mountains), central Pennsylvania, West Virginia, and into the South. The fragmentation of the nation's main manufacturing belt into eastern and western subregions is explained in part by this physiographic feature. This is not to imply that hilly lands always have little industry or that flat lands always have much industry; but in this instance there is a meaningful relationship, because the type of settlement pattern which has developed in this part of America throughout 200 years, the type of economy which prevails, and the type of industries which the market has demanded and the raw material resources supported, have all contrived to make the rough country of New York, Pennsylvania, and West Virginia less attractive for factories than flanking regions.

Through this physical barrier nature provided two valley gateways, linking the Atlantic Coast with the interior. The Hudson-Champlain lowlands extend north from New York to the St. Lawrence Valley region of eastern Canada. The Hudson-Mohawk lowlands extend north from New York, then westward to that part of interior United States and Canada fronting on the Great Lakes. The pattern of industry here consists of several industrial cities in a line like beads on a string, a pattern which prevents the seaboard portion from appearing completely separated from the interior portion of the nation's main manufacturing belt. The Central New York Region is delimited to include the cities of the Mohawk Valley and the Lake Ontario plain to the west as far as the Buffalo-Niagara Falls area.

Industrial characteristics. More than 400,000 people in the region just outlined are factory employees. Buffalo is the largest industrial center, having about as much manufacturing as Baltimore. Rochester has about 106,000 factory employees. The Tri-Cities, Syracuse, and Utica-Rome all have over 40,000 employees each.

No particular industry characterizes this region the way the apparel industry characterizes the New York metropolitan area. Primary

manufacturing is largely limited to the Buffalo area; the emphasis is on further fabrication of materials already processed in other factories. The industrial structure in general is diversified but varies considerably from city to city. Since each major city has its peculiar industrial structure, a legitimate question is raised as to whether this should be considered a single region at all.

Albany-Schenectady-Troy is essentially a producer of electrical machinery (Map 2.4). General Electric's huge plants comprise one of the largest factory layouts in the nation. The American Locomotive Company for years ranked first in the nation's production of steam locomotives. Slow to begin making diesel locomotives, American Locomotive finally brought sorrow to sentimental steam engine devotees by producing in 1951 its last steam engine, switching completely to diesels. The Tri-Cities in a sense are outliers of the New England and Middle Atlantic regions, since apparel—especially men's shirts and collars—and textiles are present and rank behind the two industries described above.

Sixty miles to the west is Utica-Rome, the last outlier of New England. Textiles are among the leading industries, but as one moves westward this is the last industrial center for which that is true. Syracuse, 25 miles to the west, is conspicuously different, with machinery factories such as household service machines, power equipment and typewriters, and chemical processors (especially the Solvay Company), predominant. Furthermore Syracuse possesses a raw material resource for manufacturing: salt deposits in the rock formations beneath the city. Exploitation of this resource sparked the growth of Syracuse's chemical manufacturing.

Rochester, another distinctive manufacturing center, is 60 miles west of Syracuse. In two respects, Rochester represents an unusual industrial community: one company far overshadows all the others and there is no clearly defined industrial area within the city. The Eastman Kodak Company probably employs one-fourth of Rochester's 106,000 industrial workers. Its several factories in different parts of town are conspicuous features of the city's physical structure. Companion industries which have developed along with Eastman are Bausch and Lomb Company, producers of optical equipment, and many firms which produce scientific instruments. It is this aggregate of instrument producers which distinguishes Rochester. Yet two other industries are so developed as to give Rochester something in common with other centers in this part of the country: machinery, represented by General Motors' Delco Division and International Business Machines, and men's clothing, notably Hickey-Freeman, Timely, and Fashion Park. Rochester further illustrates an interesting historical change which characterizes a distinct type of industrial city: that type which originates with the development of a single industry based on one particular factor but which, after the original industry's disappearance, grows in subsequent years through other industries. Rochester's original rise to manufactural prominence was in the early 1800's as a flour milling center. The falls of the Genesee River —in the heart of Rochester—provided a site for considerable power production. Wheat came via the Erie Canal from the wheat-producing lands of western New York, Ohio, and the midwestern states. Rochester at one time was in fact the nation's leading flour miller. But cities to the west subsequently developed advantages which wrested this leadership from Rochester, and it eventually ceased its milling operations altogether. Obsolescence has made its water-power importance likewise but a memory. Yet the city has continued its growth through the impetus originally given by that early combination of favorable factors.

The problem of delimiting geographical regions of manufacturing becomes complex in the case of Buffalo, which lies at the western end of the Central New York Region. Buffalo is clearly a different type of industrial city, being much more akin to Cleveland and Pittsburgh than to Rochester or the Tri-Cities. Buffalo is primarily a steel producer. The Bethlehem Steel Company's extensive plant in Lackawanna, immediately south of Buffalo, is the area's leading industry (Map 2.10). In this case Buffalo illustrates a type of industrialized city which grows through a transplanted enterprise. For many years the Lackawanna Steel Company, now owned by Bethlehem, had functioned in Scranton, Pennsylvania, processing local iron ores. As the ore supply became

exhausted, new discoveries of ore were made in Minnesota. It became clear that the Scranton company would be better off using the rich ores from the west. Since coal for its smelters was also coming from western Pennsylvania, the company decided to shift its location somewhat to the west where it could assemble the ore and coal more economically and still have access to its eastern market. The selected location was at Lake Erie's deepest penetration toward that eastern market; the selected site was the unsettled flats south of Buffalo. The new community that developed around the mill received the company's name, Lackawanna. Today the Republic Steel Company also has a small primary steel mill here. Together these mills have an annual capacity of three million tons of steel.

Other important industries in Buffalo are machinery, especially of the electrical type, with Westinghouse and Western Electric both having large labor forces, and automotive equipment (Maps 2.4, 2.14). Several auto assembly plants as well as the Twin Coach bus factory are situated here. Although dwarfed in terms of employment by the above-mentioned producers, Buffalo's flour milling industry is exceeded only by that of Kansas City, making it one of the world's leading flour milling centers (73). Almost entirely mechanized, the industry is staffed by fewer than 4,000 people, operating numerous mills located at intervals over a ten-mile stretch of Lake Erie waterfront. In the northern portion of the Buffalo industrial area the electrochemical and electrometallurgical industries have taken root, many in the vicinity of Niagara Falls. For example, DuPont produces cellulose materials and National Carbon and Carbide produces abrasives.

In smaller centers on the Lake Ontario plain a widespread canning industry has developed. Located on the lee side of Lake Ontario, possessing a flat lake plain and good soil, this region is a major producer of fruits and vegetables.

In conclusion, the Central New York Region is seen to be a diverse assortment of differing nodes of industry, unified in terms only of location in a linear pattern athwart the historically important New York State Barge (Erie) Canal, the current main highway routes, and the four-track thoroughfare of the New York Central Railroad.

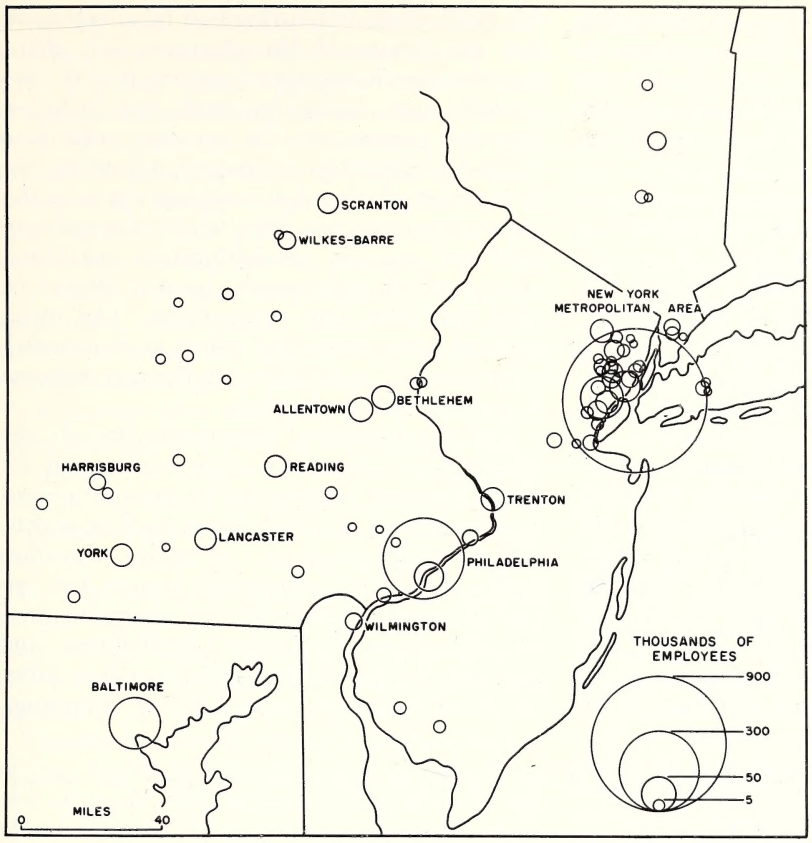
Middle Atlantic Region

The leading manufacturing region in America extends from Greater New York to Baltimore (Map 2.7). The locational pattern somewhat resembles a narrow corridor, extending southwest from New York City to the Delaware River, then fanning out broadly to the west to include Scranton and Wilkes-Barre. The Pocono Highlands of eastern Pennsylvania and New Jersey have little industrial settlement. Much of southeastern Pennsylvania, the western fringe of New Jersey, and adjacent segments of Delaware and Maryland are included in this conspicuous concentration of manufacturing which is frequently termed "The Middle Atlantic Manufacturing Region." There is need for a more definitive title, since the term "Middle Atlantic" is used by many authorities (e.g. the United States Census) to designate the trio of states, New York, Pennsylvania, and New Jersey.

Approximately four million people are employed in the factories of this region, representing about one-fourth of the industrial employment in the nation. Indeed, the nation's largest community of factories is Greater New York, employing an aggregate of 1,805,000 people. New York with $15,293,350,000 of value added by manufacture in 1958 far surpassed second place Los Angeles, with its $6,987,760,000.

A region of contrasts. Middle Atlantic manufacturing has a wide diversity of industry. Nearly every type of industry is present. On the one hand there is heavy industry, such as primary steel factories (e.g. the Bethlehem Steel Company at Sparrows Point, Maryland or United States Steel's new Fairless Hills plant in Bucks County, Pennsylvania). Shipbuilding yards, the largest in this country, are at Sparrows Point, Philadelphia, and the "Jersey Side" of Greater New York. On the other hand, complicated light industries are represented by the Hamilton Watch Company at Lancaster, Pennsylvania.

Within the region there is the large industrial metropolis (e.g. New York, Philadelphia, Baltimore) as well as numerous small indus-



2.7. United States — Location of Manufacturing in the Middle Atlantic Region.

trialized communities such as Pottstown (population 20,000 with manufactural employment 9,000), Hanover (14,000=5,500), Conshohocken (11,000=4,500), Coatesville (14,000=6,000), and Bristol (12,000=5,000)—all in eastern Pennsylvania. Some industries specialize in processing American raw materials. Others, especially the "port industries," change the form of raw materials delivered by ship, often from foreign sources. Sugar refineries are located in Philadelphia, and oil refineries are found at Bayonne, New Jersey and Marcus Hook, Pennsylvania.

This is a region of old as well as new industries. It was the nursery, though not the birthplace, of America's steel industry. Some of the factory companies date back to the late 1700's. Yet the nation's largest new steel mill, the Fairless Hills, is also here. The nation's tallest factories, the multistoried apparel factories on Manhattan Island, as well as modern, one-story, "all-on-one-floor" factories, are present.

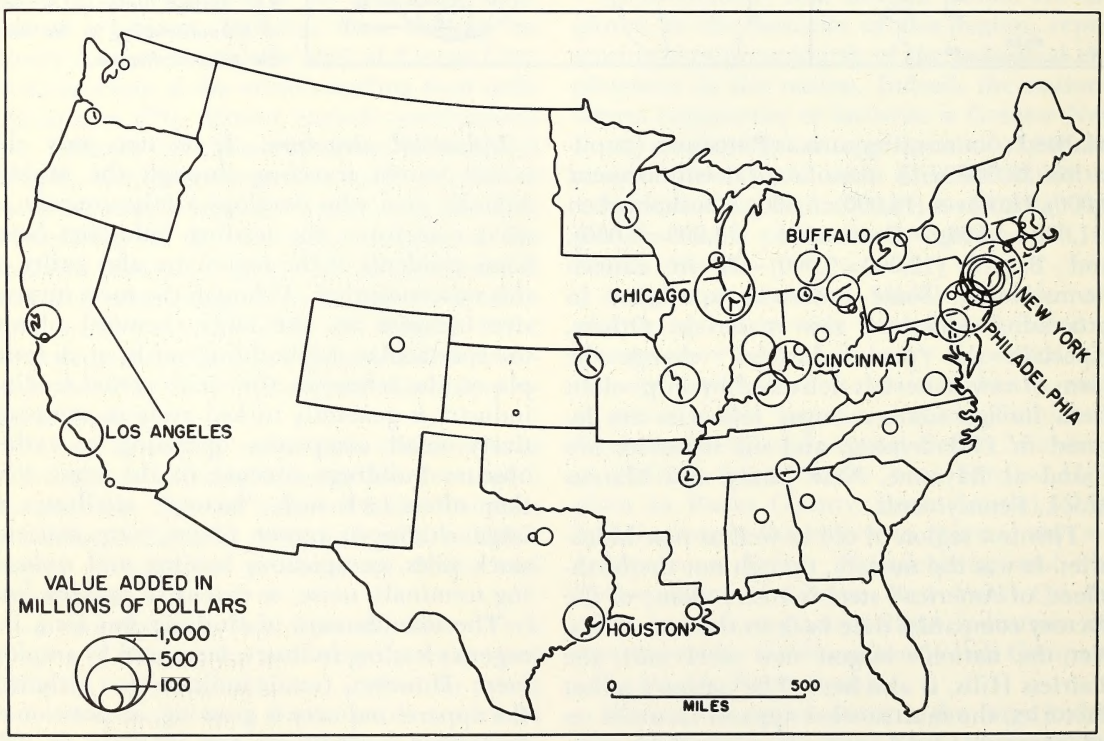
Industrial structure. It is not only the casual tourist traveling through the Middle Atlantic area who develops a false concept of what constitutes the leading industries here. Some residents of the region are also guilty of this misconception. Although the most impressive factories are the large chemical plants, the spectacular shipbuilding yards, or in some places, the refineries, the area's actual leading industry is generally tucked away in comparatively small companies operating in rather obscure buildings—obscure in the sense that they often lack such "factory" attributes as large chimneys, power plants, raw material stock piles, conspicuous loading and unloading terminals, noise, or extensive parking lots.

The manufacture of clothing was long the region's leading industry, measured by employment. However, trends indicate that although the apparel industry is growing, its position of leadership is declining. For example, in 1939 there were more than 500,000 people employed

here in making clothing. Although increasing its payrolls to about 600,000 employees in 1958, apparel declined to approximately 15 per cent of the regional industrial employment. This indicates an unusually rapid expansion in other types of industries.

The manufacture of machinery is now the first-ranking component of the Middle Atlantic industry and accounts for about 20 per cent of the manufactural labor force (Map 2.15). Today, electrical machinery is most prominent, although for several decades the leading type produced was the so-called machinery for special industries, such as textile and printing machinery. The term electrical machinery includes a very wide range of equipment, such as electronic tubes, batteries, radios, telephones, lamps, wire and cable, welding equipment, control mechanisms, transformers, motors, generators, meters, and related electrical products. It may well be that the future growth of electrical machine production will propel it into leadership among American industry and that development of this kind of manufacturing will be so extensive that the Census of Manufactures will abandon the classification and replace it with two or more new categories, each less inclusive than the present one. In any case, regardless of the diversity of its component industries, the production of electrical machinery is now the most important here. Other kinds of machinery produced are the special-industry machines, metalworking equipment, pumps, elevators, office machines, and refrigerators. The trend in machinery, including electrical, is dramatically upward, rapidly closing the gap between it and apparel production.

Other industries of importance include the ubiquitous bakeries, bottling works, and ice cream factories, augmented by canning plants, sugar refineries, and some meat-packing plants. Textile mills produce a diversity of rather high quality goods, especially hosiery and carpets. Primary metal industries producing steel are found in Baltimore, Bethlehem, and now the Fairless Hills plant. Secondary fabricators of such metal products as stampings,



2.8. United States—Chemicals and Products—1958.

structural units, and tools are found in numerous factories, usually small individually but with a rather large aggregate employment. Printing and publishing are prominent in the form of numerous daily newspaper plants, periodical publishers and textbook manufacturers. The Middle Atlantic Region is the heart of the nation's expanding chemical industry, represented here by producers of plastics, medicines, pharmaceutical preparations, soap, paint, toilet preparations, ink, and a diversity of industrial organic chemicals. The shipyards of Camden, Baltimore, and the New York harbor area are conspicuous industrial types and produce most of the nation's ships.

Analysis of cause and effect relationships (such as the factors which have caused so much manufacturing to thrive in the Middle Atlantic), the significant consequences of manufacturing, its impact upon the total geography of the Middle Atlantic area—all can be observed more clearly after a closer inspection of the industrial geography of major manufactural localities within the region.

Greater New York. Most Americans fail to realize that New York City with its suburbs is one of the leading manufacturing areas in the United States. From casual investigation it appears that people think of Pittsburgh as having more industry than New York. Yet New York has almost six times as much manufacturing as the Steel City. New York is widely known as a commercial and financial center, yet with more than 1,800,000 people employed in manufacturing it contains more than one-tenth of the entire nation's industry and has nearly half again as much as Chicago, the nation's second largest concentration of industrial employees.

Structure. Greater New York's industrial structure is basically the same as that pertaining to the Middle Atlantic area which is not surprising when one recalls that New York comprises nearly one-half of Middle Atlantic manufacturing.

Apparel industry. The focal point of the apparel industry is in Manhattan. Thousands of garment workers are employed in the upper stories of hundreds of structures which from the outside appear to be office buildings or stores. Close observation reveals however that where the first floor is devoted to retailing clothes, the second floor may be devoted to wholesaling, while the third, fourth, fifth, etc. will contain the sewing machines, cutting machines, and sewing tables at which the workers produce the goods sold below. The concentration of factory workers in such an area is intense. The activity here is well described by Cox (37).

> Within New York City the heaviest concentration is in the 150 acres bounded by the Pennsylvania Railroad Station on the south, Times Square on the north, Seventh Avenue on the east, and Ninth Avenue on the west. Here in loft buildings are the several thousand small enterprises that comprise the industry; two-thirds of them are of the contractor type. In the neighboring streets are also the buyers and sellers of highstyle fabrics, feathers, furs, and whatnot.
>
> Because it is built upon fashion and behaves accordingly, the district looks to the casual visitor more like a madhouse than anything else. To pass through its streets at lunch time is an unforgettable experience. Its sidewalks are so jammed with throngs of garment workers who have poured out of its buildings for a breathing spell that through traffic is virtually stopped. The buildings house a jumble of showrooms, workrooms, storerooms, and offices. Through them passes a stream of buyers looking for goods they can sell to the customers of the retail stores they represent. Boys push little carts around through the streets, carrying a dozen or two dresses or coats at a time from one workshop or showroom to another. In offices scattered throughout the section, employers and workers argue out their recurring disputes over wares. Throughout all these operations runs a high nervous tension.
>
> Madhouse though it may seem, the garment center and its way of doing business are a logical answer to the fundamental force which brought them into existence—fashion. It provides two fundamental needs: First, it enables everybody to keep in touch with what everybody else is making and with what the consumers of the country and the storekeepers who represent them in this market are buying. Second, it makes possible great speed in setting up facilities to produce a particular style while the demand for it is good, closing them down when demand falls off, dropping styles quickly before stocks have been accumulated if they fail to win demand, and copying immediately anything any competitor devises which consumers like.

There are approximately 365,000 employees in New York apparel factories. This staggering figure exceeds the total employed in all manu-

facturing in Milwaukee, Boston, Cleveland, or Pittsburgh. Most of them are engaged in making women's clothing, although more men's clothing is made in New York than in any other place. Many apparel factories have decentralized toward the "Jersey Side" and some to Long Island. There is now considerable jobbing-out from Manhattan factories.

Other industries. The importance of machinery production has already been observed. What may not be well known is the fact that Greater New York is the nation's second leading machinery producer, exceeded only by Chicago (Maps 2.4, 2.15). The special emphasis is on radios, telephones, other communication equipment, and electrical machinery in general. New York leads the world in the production of such items as printing presses, linotypes, and lithographing equipment. Many of the printing machines in Milwaukee, Chicago and even Los Angeles were made in New York.

New York likewise is the center of the nation's printing and publishing industry. The large publishers all have establishments in New York, although not all of them do the actual printing of books and magazines here. Where jobbing-out is done, however, it frequently happens that contracts are let to printers in communities still within the Middle Atlantic Region.

Greater New York's food factories contain not only the ubiquitous bakeries, meat-packing plants, and bottling works producing for the tremendous local market of more than 15,400,000 people in 1960, but also produce for the regional market. Crackers and cookies from New York factories supply much of northeastern United States. Greater New York brews more beer than any other brewing center, including Milwaukee. The fifth industry with over 10,000 employees is the production of chemicals, particularly drugs and medicines, toilet preparations, paints, and plastics (Map 2.8). For all these, New York is the nation's leader.

The purpose here is not to inventory New York's industry. Enough has been said to indicate what the leaders are (the five industries mentioned comprise about two-thirds of New York's production) and to make the observation that in many industries the nation's leading producing center is Greater New York.

Industrial areas. Industrial areas within Greater New York fall rather clearly into three categories (45). Manhattan has the densest concentration of workers. Industry here typically is light, and secondary. This is the heart of the apparel, baking, and printing industries, although almost every other type including meat-packing is found. City zoning ordinances, however, are gradually decreasing the amount of odorous, noisy, or dirty factories on the island by prohibiting new firms of this type to establish themselves. Most old firms have been allowed to remain.

West of the Hudson River in New Jersey is a rapidly expanding industrial complex. Much of this land is reclaimed swamp and harbors, most of which is occupied by the region's heavy industry: foundries, machinery producers, oil refineries, shipyards, electrical producers, and breweries. Bayonne is generally known to be the home of many refineries and Esso is located at Linden. The Naval Industrial Reserve Shipyard is at Kearny, as is Western Electric's huge plant. Not all the industry is "heavy." Many of the apparel producers are migrating to this western area. New York planning authorities look upon this as a natural area for new industry and are allocating considerable land for that purpose. An intrinsic advantage of the New Jersey side is its location on main-line railroads.

The third area is in Long Island, which is somewhat intermediate in type between the light industry of Manhattan and the heavy industry of New Jersey. Many of the foods industries, such as sugar refining, bakeries, and some meat-packing, are found here. Airplane production, particularly Grumman's factory, and electrical instruments, such as Sperry Gyroscope, are on Long Island. Favored with many advantages for residential settlement, including open land for factories, but rather removed from main-line railroads, the Long Island area probably will lure the lighter forms of industry in which labor represents a comparatively large portion of production costs.

Relationships. In order to understand the development of New York industry—its large extent, its structure, and its pattern—one must consider its relationship with several specific factors.

In the first place, New York is the focal point for most of America's market. This metropolitan area is closer to more people than is any other place. Demand from this zone for manufactured goods is the major stimulus to New York's manufacturing. Moreover, as the nation's leading port, New York has advantages for factories serving foreign markets. One of America's leading manufactured exports is electrical machinery; it is not surprising that New York is the nation's leading producer. However, New York manufactural employees constitute a market for other economic activities, which in turn increases the demand for manufactured goods. Thus, manufacturing is both result of and cause of this region's purchasing power.

Traditionally, attention is given to raw materials and power, important factors without which manufacturing cannot survive. New York is quite removed from both. It never was blessed with many water-power sites; coal has been brought several hundred miles from western Pennsylvania or even barged from Hampton Roads. With all its steel consumption, New York does not possess a single steel mill. In other words, New York and her hinterland produce none of the power and scarcely any of the materials consumed by her factories. Coal, steel, sugar, petroleum, sulphur, leather, paper, fabrics: all are imported from distant places, some are even brought in from foreign countries.

What the New York area lacks in natural resources is compensated for by her wealth of human resources: her labor, management, and research productivity. No other urban area represents such a collective endowment of these three components. Again, the relationship is reciprocal. These human resources create more manufacturing, which in turn creates more jobs. Concomitant with such human resources is the supply of risk capital in the New York area. As the commercial and financial heart of a prosperous nation, New York has been a collecting point for some of the profit produced by this nation's productive effort. Much of that profit has become investment capital. It is generally known that investments by New York authorities are made in a host of widely dispersed places throughout the world; nevertheless much of the money has been available for industrial investment in Greater New York itself.

Interwoven with all the relationships mentioned is the role of transportation. Access to a vigorous market demands good transportation, because a place separated only a few miles from a market, when linked by poor transport, is in reality farther away than a more distant place connected by excellent transport. Good transportation has made New York the nation's leading port, linked it with the nation's area of greatest purchasing power, and tied it to source areas of raw materials and fuel. Three components of transportation have, by their excellency, stimulated New York's industrial development. First, the natural harbor is familiar to every geography student. With the Hudson, East, and other river estuaries, the port of New York has ample depth for ocean ships, well protected from the sea. The 770 miles of waterfront provide unequalled space for construction of port facilities. Secondly, the early development of inland waterways gave New York an advantage over Boston, Philadelphia, and other East Coast ports which has never been lost. The Hudson Valley with its navigable river connecting near Albany with the Mohawk Valley penetration to the west gave New York a corridor to the productive interior of the United States unmatched by any other eastern city. Indeed, one may wonder what the relative status of Boston and New York today would be if the Hudson Valley had extended east to Boston rather than south to New York. With the construction of the Erie Canal in 1825 through middle New York, water transport routes linked New York with Lake Erie and Lake Michigan harbors and stimulated traffic which led to the quick birth of interior port cities. The third transport element is the railroads. Building westward from the Atlantic seaboard in the 1830's, 1840's, and 1850's the rails penetrated the interior and many converged on New York. Today five trunk line routes—the Pennsylvania, New York Central (merger of these two railroads was initiated January 1962), Baltimore and Ohio, Erie, and Nickelplate-Lackawanna—connect New York with Chicago. Herein lies part of the explanation of industry's rapid development on the New Jersey

side of Greater New York: all of these railroads, plus several others serving only Atlantic seaboard states, terminate on the west bank of the Hudson. Thus New Jersey not only has land for factories, it also has a dense network of rails from which sidings and spurs have been constructed. The contrast in rail pattern alone reveals many significant aspects of the industrial geography of New Jersey, Manhattan, and Long Island. The recent advent of trucking has found the highway net in this metropolitan area adequate to sustain the factory demands for such service.

Obviously, the concept advanced here is that transportation is a key to the functioning of every industrial area. Places with no transport, if endowed with power or raw material resources, can lure transport to them, along with the necessary labor to manufacture these resources for shipment of products to other places. But it is also true that a place with no power or material resources can, with ideal transport links to both producing and consuming areas, attract the necessary labor to develop considerable industry. Such a manufactural center is Greater New York.

Trends and the future. Greater New York has experienced its major expansion since World War II on the urban fringe. Five of every six new factories have been built outside the major industrial districts existing in World War II. Yet almost all are within a 20-mile radius of downtown Manhattan. A major new factory area is located in New Jersey extending from Paterson on the north to Linden on the south. In this area most of the new industries are in the heavy factory class, especially chemicals. The concensus of opinion among industrialists is that New Jersey sites offer: (a) more space for expansion, "all-on-one-floor" factories, parking facilities for employees, landscaping, and recreational facilities, (b) better accessibility to the residential areas of more employees, (c) better access to transportation, especially rail sidings and truck docks, without the necessity of hauling goods across Manhattan, (d) less probable vulnerability to attack in case of war, (e) steadier and more predictable—though not necessarily lower—taxes than in New York City. This outward expansion—a mobility of factories—is made possible by good transportation, which enables factories dependent on railroads and those dependent on trucks to function, and to be more accessible for the great numbers of employees who wish to drive their own cars to work.

The core of Greater New York is still its industrial heart, but recent growth has been surpassed by that on the outskirts. It would appear that the same forces which have operated to make New York the nation's number one center of manufacturing will continue to cause industrial expansion unless federal authority should disrupt these forces by forcibly causing dispersion to other areas. As manufacturing in Greater New York expands it most likely will grow mainly along the rail and highway transport routes to the west and south.

Philadelphia. Philadelphia is located about 80 miles southwest of New York. At the confluence of the Delaware and Schuylkill rivers, it long has been an important seaport and commercial center. On the momentum of this activity, Philadelphia quickly developed the wide diversity of industries typical of large port cities: processing of goods for the local and tributary market, processing materials from foreign sources for distribution in the United States, and processing some goods for foreign export.

Today, the Philadelphia metropolitan area has about one-third the manufacturing of New York and is also surpassed by Chicago and Los Angeles. Philadelphia's industry is more diversified than New York's; no single industry predominates. Machinery, textiles, and apparel are the leaders. For many years textiles ranked first; Philadelphia still leads the nation in production of women's hosiery, carpets, rugs, and hats. Textile machinery has become one of the distinctive types of machinery produced, harmonizing with the principle that as a region's manufacturing matures it tends to produce the machines used in the factories of its leading industries.

Another contrast with New York is the presence of primary steel production. Blast furnaces at Morrisville, Norristown and Conshohocken in the north and west portion of Greater Philadelphia are among America's earliest iron and steel processors.

Pattern of manufacturing. Four general

factory districts are discernible in the Philadelphia area. The central core of the city is the heart of the apparel industry. In contrast to New York, more men's than women's clothing is produced. This relates to the slowness with which men's styles change; rapidity of style changes in women's clothing is a powerful force driving manufacturers to locate as near as feasible to the nerve center of those style changes. This reduces the time interval between declaration of the new style and its manufacture; it also provides most rapid contact with the largest number of buyers and salesmen. Not quite so well located, Philadelphia's apparel makers have concentrated more on men's clothing. Several New York producers of men's apparel moved to Philadelphia because Philadelphia's labor costs were lower, even as late as the 1930's. Unionization in that decade leveled off these differentials. Manufactural operations are carried on in the upper floors of loft buildings, as in New York.

A second area, in the northeast portion (especially along the Pennsylvania Railroad), has a tremendous concentration of industry. Numerous woolen and worsted mills are in the older portion of this area. Farther out in the newer sections the metal fabricators predominate. Ball bearings, lift trucks, overhead trolleys, and tin cans are only a few of the items coming from those factories for which new ground is continually being broken. Open flat land served by railroads and highways makes this a rapidly growing industrial zone.

An extensive belt of land adjacent to the Delaware River is a third industrial area. It includes the New Jersey side east of Philadelphia and both sides of the river south of the city. Camden, on the New Jersey side, has been famous for its shipbuilding industry, dominated by the United States Navy Yard, which has constructed more of our naval vessels than any other yard. Here also is the R.C.A. communications equipment factory, and the Campbell Soup plant, which processes most of New Jersey's tomato crop. This factory has attracted to its immediate vicinity a can factory which, by means of overhead chutes supplies the cans for the soup—a highly localized example of the influence of market in determining the location of an industry. Tributary to and downstream from the Schuylkill confluence is Philadelphia's most concentrated manufacturing section. Actually this belt extends for 20 miles to Wilmington, Delaware and is one of the major chemical belts in the country. On both sides of the river many new chemical plants have been constructed with that of E. I. Du Pont de Nemours and Company being the largest. Du Pont has several separate plants here, producing explosives, cellulose, industrial alcohols, chlorine, dyes, acids, and refrigerants. The Marcus Hook portion of this valley has the largest concentration of refineries on the Atlantic Coast. The Sun and Sinclair companies on the Pennsylvania side have considerable developments here. This territory has also been called "the American Clyde" because of its shipbuilding, situated in Camden, Chester, Philadelphia proper, and Wilmington. However, this industry fluctuates notoriously, booming during war years and nearly collapsing in peacetime. Without government subsidy the American shipbuilding industry apparently cannot compete with the low labor costs of foreign producers. One of the most conspicuous factories in this area is the Baldwin Locomotive Works which, originally in Philadelphia, many years ago moved to Eddystone for more and cheaper land on which to expand as well as for lower taxes. For decades the Baldwin Company had been a leader in producing locomotives—all steam. After World War II the American demand was almost entirely for diesels; Baldwin was slow to change and saw much of the market swept away by a new competitor, General Motors, which had anticipated the shift in the railroads' demands. Auto assembly plants also typify the lower Delaware Valley.

The fourth industrialized portion is to the northwest along the Schuylkill River. This was the seedbed of Philadelphia manufactory. About ten miles from its confluence with the Delaware River, the Schuylkill crosses the Fall Line, a transition from the rougher, older rocks of the Piedmont to the flatter more recent Coastal Plain. The rapids constituted a natural water-power site, which the early settlers harnessed. This, combined with the skill of textile workers among early immigrants from western Germany, were major

factors in the early start of the textile industry in this particular place. In fact, the settlement of Germantown is generally considered the originating point of Philadelphia's manufacturing. Since the Schuylkill is not navigable except for very small craft, few heavy industries have been established in the valley except ones that could be supplied by rail. Historically speaking this also was the home of many early steel mills, the industry persisting in Conshohocken and Norristown.[3]

Trends and the future. Philadelphia manufacturing is growing but not as rapidly as in New York. In a way this seems surprising, for there is more flat land and more miles of available waterfront along the navigable Delaware. With approximately the same labor situation Philadelphia apparently lacks New York's advantageous contact with markets.

Philadelphia is situated near the southwestern end of a 120-mile linear belt, stretching from New York to Wilmington, which is almost certain to experience an influx of factories. Smaller communities will receive new plants, as deconcentration occurs, from New York and Philadelphia; even rural areas can expect to be transformed by the location of manufacturing. A prize example of this is the Fairless Hills iron and steel plant in Bucks County, Pennsylvania, where United States Steel's $450,000,000 investment transformed the rolling countryside.

The new mill itself employs about 6,000 people and has a capacity to produce 1,800,000 tons of steel a year. This is about 2 per cent of the national output. The repercussions of this one plant on the surrounding area would constitute a fascinating study in social research. It is certain that this mill has attracted other factories which use its steel and serve eastern markets. For example, the National Tube Company has followed U.S. Steel to the area. The most conspicuous consequence has been the urbanization of a formerly rural setting. A building company purchased a 1,200-acre site four and one-half miles from the steel mill and began in June 1951 to construct a planned community, with residences, stores, schools, civic buildings, and public utilities. Of prefabricated construction, the houses were erected rapidly. By January 1952 over 1,100 homes were finished. Fairless Hills in 1962 had over 3,500 homes and a population of 14,000. Obviously this settlement houses only a minority of the people employed by the steel mill and subsidiary industries.

The new development in Bucks County is simply the most dramatic example in the considerable expansion of manufacturing along the Delaware Valley. On a navigable waterway the belt has access to ocean shipping thus linking the Fairless Hills plant directly with the new ore fields in Venezuela and Labrador. It is also situated near the heart of the American market and on excellent transport links—the main lines of the Pennsylvania and Baltimore and Ohio railroads, as well as U.S. Highway 1—to that market. Extensive flat land provides building sites.

Baltimore. Baltimore is the southwestern outpost of the nation's most industrialized belt, a belt which extends nearly 400 miles to northeastern Massachusetts (31). With about 197,000 manufactural employees it has about one-tenth the industry of New York. It resembles somewhat the Middle Atlantic type by having some apparel manufacture, but is distinguished by its heavy industry. The Bethlehem Steel Company has a large plant at Sparrows Point. The Bethlehem Shipbuilding Company adjoins the steel mills and creates the only situation in America where steel moves directly from mill to shipyard.

One of the largest defense plants in America is the Martin Company factory. Baltimore is also the leading canning center on the East Coast. Like Camden and many other cities of the Atlantic Coastal Plain it processes the vegetables from the nation's most extensive truck farming areas.

The manufactural areas just described (New York, Philadelphia and the Delaware

[3] Some claim that a Coatesville steel company (Lukens) is the oldest iron and steel (plate) producer in the nation, and dates from 1793 when a Chester County farmer, Isaac Pennock, established a very small mill outside Coatesville. Using charcoal to smelt the iron ore, he produced plates which he then cut into rods to supply local blacksmiths. In 1810 Pennock acquired a defunct sawmill property in Coatesville and transplanted his steel mill. Since July 2 of that year steel production has been conducted continuously, a period of over 150 years.

Valley, and Baltimore) comprise the mainstays of the Middle Atlantic manufactural region. Lesser centers such as Trenton, New Jersey; Scranton-Wilkes-Barre, Allentown-Bethlehem, Harrisburg, Reading, Lancaster, and York, Pennsylvania, plus many smaller cities, are also comparatively highly industrialized, making the area conspicuous on a map of relative industrialization in the United States. In most of these are found industries similar to those already observed in the major centers. Textiles and apparel are found nearly everywhere. Machinery and chemical products are, however, among the most rapidly growing industries.

Pittsburgh-Cleveland Region

From the southern shores of Lake Erie southeastward for 125 miles extends a zone of manufacturing, clearly differentiated from many less industrialized areas to the east, south, and west (Map 2.9). The axis of the region extends from Cleveland to Pittsburgh but includes such outlying manufactural cities as Wheeling and Johnstown. Major manufactural centers with the number of industrial employees in each are listed below. The aggregate of these and lesser communities is approximately 900,000 which is about two-thirds that of New England.

TABLE 2.11

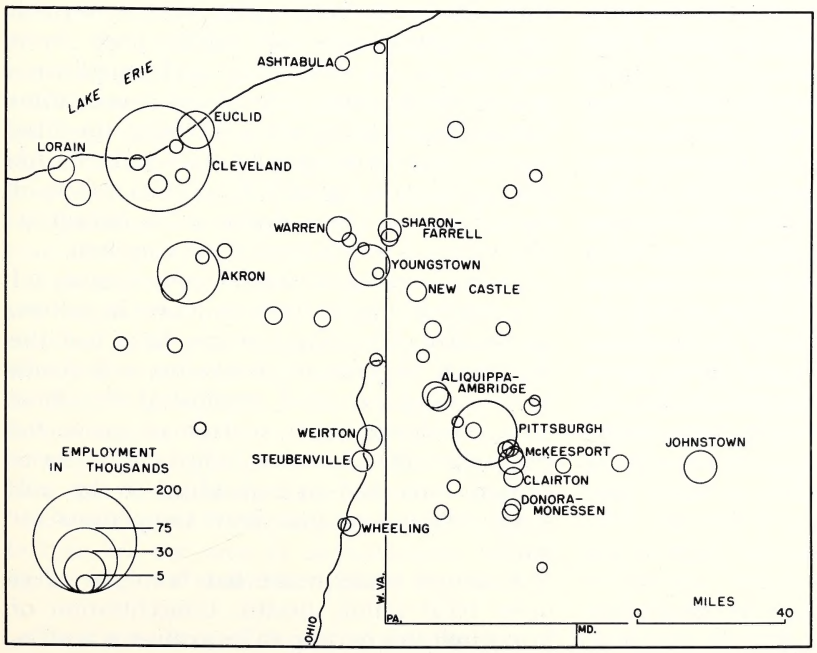
Thousands of Manufactural Employees
Standard Metropolitan Area

Pittsburgh—318
Johnstown—23
Cleveland—264
Youngstown—76
Akron—83
Canton—51
Weirton-Steubenville—30
Erie—34
Wheeling—17

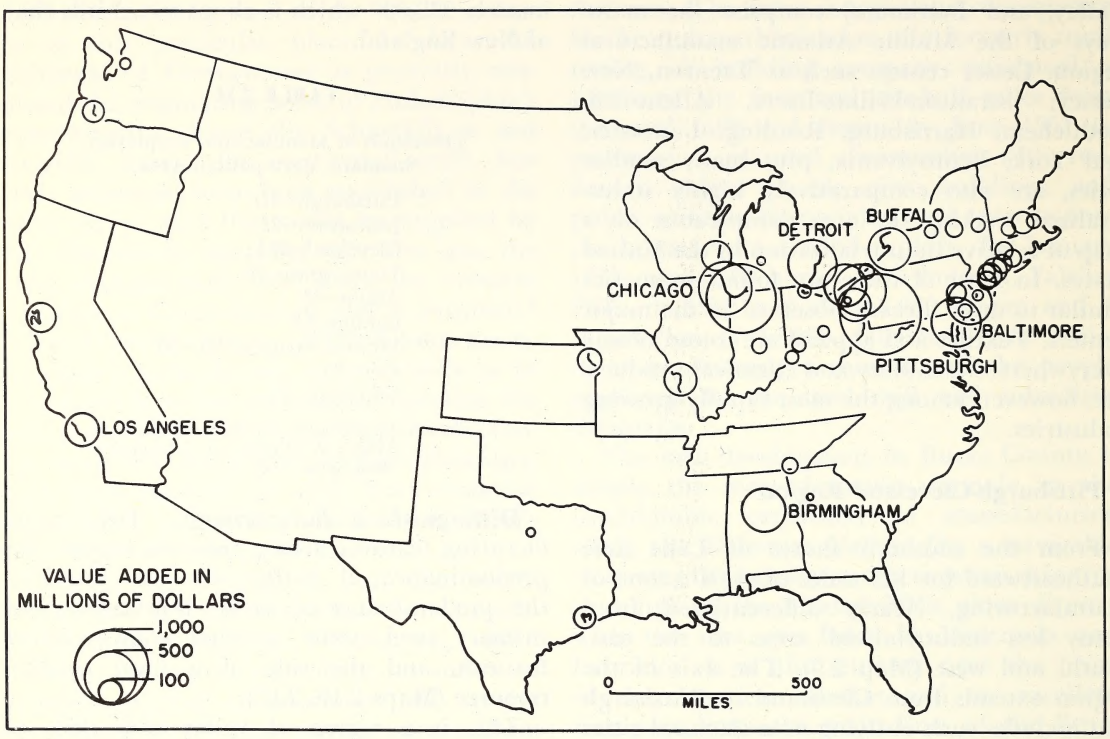
Source: United States Census of Manufactures, 1958, U.S. Department of Commerce, Washington, D.C.

Distinguishing characteristics. Four manufacturing features distinguish this region: the predominance of valley sites for factories, the predominance of metal fabrication and primary steel, some unusual transportation features, and the role of a local mineral resource (Maps 2.10, 2.12).

This is a region of valley sites (65). In Pittsburgh some of the hills rise 400 feet above the valley bottoms. The industrialized valleys are a small segment of the dissected Appalachian Plateau, where there is very little



2.9. United States — Location of Manufacturing in the Pittsburgh-Cleveland Region.



2.10. United States—Primary Metal Industries—1958.

flat land on the interfluves. On the bottom lands of the Monongahela and Allegheny, the Beaver and Shenango, the Mahoning, and the Cuyahoga rivers are found most of the sites upon which factories through the years have been built.

Manufacturing has chosen the valleys not only because of available land but also because of transportation advantages. In the early days the advantage was water transportation on the rivers mentioned above. Today the Monongahela continues to have the densest river traffic of any river in the nation, except the Detroit River and the Soo Canal, which in reality are simply narrows in the Great Lakes. The initial flow was that of coal from mines to the south moving by barge downstream on the Monongahela and Youghiogheny rivers. The next step was railway construction, which followed valley routes, adding another premium to the valleys as sites for factories. The railways in this region almost duplicate the valley pattern.

A third asset of valley sites is access to river water for cooling purposes. It is no exaggeration that waters of the Monongahela and Mahoning are used over and over again by the coke mills, blast furnaces, and steel mills along their channels. The waters become warm—temperatures of 140°F have been recorded in the Mahoning at Youngstown—and markedly dirty. The sharp demarcation line at Pittsburgh's Golden Triangle, the dirty waters of the Monongahela, which is lined with steel mills, merging with the cleaner waters of the Allegheny, which drains a less industrialized valley, is a well-known phenomenon.

There have been several consequences of this tendency for factories to locate in valleys. In the first place the factories have had the additional expense of excavating hill flanks to provide space. Once established they have been handicapped by a lack of room for expansion, often hemmed in by other factories equally interested in expanding, or by railroads, which have also been competitors for land.

A second consequence has been the effect upon local public health. Concentration of heavy industry in deep valleys causes a ventila-

tion problem. Air circulation is less effective in clearing smoke and waste gases away from the factories than when they are located on plains, where circulation is unimpeded. Settlements in the valleys and on the valley slopes are consequently notoriously dirty. Worse than the dirt itself are the toxic gases. Jokes about Pittsburghers being unable to keep a clean white shirt or wiping dirt from window sills with their finger tips may have been funny, but the consequences of poison gases are serious. Such gases tend to be contained in the valleys when the atmosphere experiences a "temperature inversion." Circulation then is impeded horizontally by the topography and vertically by contrasting densities of air layers. The Donora smog of 1949 illustrates the seriousness of the situation. In late summer of that year a smog hung low over the Monongahela, trapping poison gas from the stacks of a zinc smelting factory. Hundreds of people were treated for paralysis of the respiratory system; 19 died. One health authority estimated that "there would have been a thousand dead had not the rain cleared the air." [4]

A second distinguishing characteristic of the Pittsburgh-Cleveland Region is the predominance of metal industries. Fully two-thirds of the labor force is so engaged. In Pittsburgh, that proportion reaches 67 per cent, Cleveland 65 per cent, Canton 75 per cent, and Youngstown 85 per cent. Akron, in this respect, has a different structure; dominance of the rubber industry there lowers the metal goods proportion to 20 per cent (Map 2.13). Primary metals, fabricated metals, and machinery are present in significant amounts in the region's industrial structure.

Primary metal manufacturing has made this region famous. For decades it has produced a large percentage of the nation's pig iron and steel; the reputation of Pittburgh as the "steel capital" is widely known. The factors operating in the initial location and subsequent prosperity of the steel industry here are analyzed in detail in the chapter, "Iron and Steel." The impact of steel manufacture on the area is unmistakable. Much of the region's economic welfare depends on the activity of "the mills." A large percentage of the labor force is of eastern or southern European descent. Neighborhoods of steel workers occupy the slopes and tributary valleys adjoining the mill sites. Primary metals are the single most important industry in this region. Similarly, this is the most important region in the nation's pattern of primary metal manufacture.

Secondary fabricators have developed in the region as a response to the availability of steel from the blast furnaces and the demands of the nation's great northeastern market. Actually, this last relationship is reciprocal: the presence of these fabricators constitutes an expanding market for the steel mills. The term fabricated metal products is a rather broad one including a diversity of such items as structural steel, boiler shop materials, metal stampings, castings, bolts, and nuts, heating and plumbing fixtures, and ornamental steel work.

Machinery, including electrical, completes the trio of metal industries (Maps 2.4, 2.15). Located in the middle of the nation's machinery belt, the region produces a wide variety of practically every type of machine. The ultimate stage in a region's industrial maturity is the appearance of machine tool factories, which make the machines demanded by the mechanized industries that produce the final food, wood, leather, metal, and synthetic goods for the consumer. Machine tools are produced in several cities of this region, but Cleveland companies have been among the most successful.

A third distinguishing characteristic is the role of transportation. The main tonnage flow is of raw materials and involves a type of reciprocal transportation: Great Lakes iron ore moving by rail from Lake Erie ports such as Cleveland, Ashtabula, and Conneaut southeastward to Youngstown, Pittsburgh and the other steel cities, and coal moving in the opposite direction. The movement of ore was not heavy during the early years of the region's steel industry, which then subsisted on local ores. But the discovery of richer and much more abundant ore in the various ranges of Minnesota, Wisconsin, and upper Michigan stimulated on the Great Lakes a rapidly increasing movement to Lake Erie ports for

[4] Dr. William Rongaus, Donora Board of Health.

transshipment by rail to existing steel centers. The New York Central (and its subsidiary the Pittsburgh and Lake Erie), the Pennsylvania, and the Baltimore and Ohio carried most of the ore, charging rates which some of the steel men felt were too high. Andrew Carnegie threatened that his steel company would build its own railroad to a lake port unless the established companies reduced their charges. Confident that the threat would not materialize, the railroads refused. Consequently, the Carnegie company constructed a double-track right-of-way from Bessemer, Pennsylvania to Erie, named it the Bessemer and Lake Erie, and began hauling ore. The orientation of the railroads in this region from northwest to southeast harmonizes with the directions of major tonnage flow.

In addition to the ore-coal flow, the region also participates in a heavy traffic of outbound products, some of which circulate within its borders but most of which are exported to the east and west into flanking portions of the main American market as well as to other parts of the nation. A small proportion goes to foreign buyers. For this outflow the region is favored by its location astride the five trunk line railroads between the Midwest and the Atlantic seaboard (Pennsylvania, New York Central, Baltimore and Ohio, Erie, and Nickelplate-Lackawanna). Lesser rail companies link smaller industrial communities with the main lines. The role of rail transport in the industrial development of the Pittsburgh-Cleveland Region cannot be overestimated in a day when this form of transport seems to be casually taken for granted. River transport is important in places, especially the Monongahela, but the largest river, the Ohio, flows westward through areas of little industrialization. It therefore plays a lesser role in the region's economy. In the past, some traffic has flowed on the small, winding Mahoning and Beaver rivers. Had the major river connected Pittsburgh with Cleveland the transportation picture would have been different. There has been some sentiment for construction of a deep canal from Cleveland to the Pittsburgh area but the project has never materialized. Pittsburgh has had a limited port development. The place of the railroads in the economic function of this region has received a fanciful challenge from competitors, who conceived of a monstrous conveyor belt from Cleveland to the Pittsburgh area. That this idea was sparked by a railroad company within this very region seems surprising until one observes that its rail line is east-west oriented.

Finally, this region is distinguished by its possession of one of the nation's great natural industrial resources, the Northern Appalachian bituminous coal field. For the first time in the regional discussion of this book, attention comes to a large region where local natural resources still comprise a major basis of manufacturing. New England had timber and water power; the one was exhausted, the second has been relegated to a secondary role. The Middle Atlantic had iron ore, which supported early industry but which likewise has become secondary to ores from other places. Industry in the Central New York Region has in only a few places been based on local resources. But the region presently under consideration has had both iron ore and coal—in fact, the nation's most lucrative endowment of the latter resource. It can be contended that the two basic factors in the development of manufacturing here involve its location in respect to (a) the main American market and (b) the major bituminous coal deposit. If coal alone were the controlling factor one might expect the pattern of this manufacturing region to extend to the southwest from Pittsburgh rather than to the northwest. In any case, the role of coal has been important, and Pittsburgh, located as it is within the main market territory, has attracted a concentration of factories to physical sites having many disadvantages which these factories would not have encountered on flatter land in the Midwest or Atlantic seaboard. Yet it must be reiterated that historically it was iron ore from western Pennsylvania and eastern Ohio which provided the first attraction for iron and steel companies. These companies initially used charcoal. Exploitation of the coal came later.

Major centers of manufacturing

Pittsburgh and her satellites. Pittsburgh and her satellites comprise the nation's fifth largest concentration of manufacturing. The

pattern of industry conforms closely to the valleys and extends mainly up the Monongahela to the southeast. Most of the heavy industry for which Pittsburgh is famous is technically outside Pittsburgh in such suburbs as Munhall, Rankin, Braddock, Duquesne, McKeesport, and Clairton. This cluster of communities epitomizes all that has been said about the predominance of metal industries, especially iron and steel (81). With a capacity of about 20 million tons a year this aggregate of communities accounts for one-fifth of the nation's pig iron and steel production. More than a dozen different mills are located on the narrow valley flats astride the Monongahela and Youghiogheny rivers. Two companies dominate the area: Carnegie-Illinois (a subsidiary of U.S. Steel) and Jones and Laughlin. Carnegie operates the region's largest coke factory, the largest in the nation, with an annual capacity of 7,500,000 tons at Clairton, the region's two largest blast furnace installations at Braddock (2,400,000 tons) and Rankin (2,100,000 tons), and the region's largest steel mill at Munhall (4,700,000 tons).

The problems of Pittsburgh resulting from the blighting influence of heavy industry, the rugged topography, and the decline of an aging commercial core combined to threaten the city's future development. Some steel industry had already moved, and those not leaving had ceased to grow. The dirt, the old buildings, the narrow streets, the congestion—problems typical of all large cities—seemed to be intensified in Pittsburgh. At the end of World War II civic leaders concluded that the city stood at a fork in the road. It could maintain the status quo or endeavor to clean up, relieve its congestion, and improve its reputation as a place in which new industry could locate and new workers could settle. Leadership chose the second course and has proceeded to give Pittsburgh a face-lifting equal to that of any other large city.

The city's physical appearance has undergone a remarkable change since 1950. Manufacturing has had a direct influence on the revamping of downtown Pittsburgh; industrialists have led the way in a program which so far has seen numerous advances. In 1948 a smoke ordinance was passed applicable to the entire metropolitan area. A noticeable decline in soot and dirt accumulation followed; sunshine increased in Pittsburgh by 65 per cent. Thirty-six acres of blighted land at the point of the Golden Triangle, formerly occupied by old warehouses, narrow streets and associated structures, were purchased for $7,000,000 to be completely cleared and rehabilitated as a state park, featuring historic Fort Pitt. Twenty-three contiguous acres of blight to the northeast were cleared by the Pittsburgh Urban Redevelopment Authority and designated "Gateway Center." Here the Equitable Life Insurance Company has constructed eight office buildings separated by expanses of green acreage. Three buildings have been constructed at an average cost of $10,000,000. The first company to occupy these offices was, significantly, a steel manufacturer. A few blocks to the northeast are two additional new skyscrapers, the 42-story stainless-steel building, headquartering U.S. Steel and the Mellon National Bank and Trust. Close by is the new $10,000,000 30-story building of the Aluminum Company of America. An entire block, converted into a park with underground parking facilities, represents a $4,000,000 gift to the city from the Mellon family. This is one of five new downtown parking garages constructed by the Public Parking Authority, apparently the first such organization in any American city created for coping with parking problems. Over $100,000,000 has been spent on a superhighway system skirting the edges of the downtown area, replacing some old river bridges with new ones, and construction of several tunnels and viaducts to serve outlying areas. Many of the poorer residential areas are being rehabilitated partly through the use of federal funds.

All in all, almost 80 acres of downtown Pittsburgh are being revamped in a city where no new major building had been constructed between 1920 and 1950. Basic to this renovation has been the success of the Pittsburgh Regional Planning Association in securing the abilities and determination of Pittsburgh's top businessmen, as well as civic leaders from all walks of life and every political affiliation.

Mahoning-Shenango Valley Area. Scarcely forty miles northwest of Pittsburgh is an industrial node, consisting of Youngstown,

Warren, Sharon and New Castle—all communities in the Mahoning and Shenango valleys. Highly industrialized, with an even greater relative emphasis on metals than in Pittsburgh, this area helps link Cleveland with Pittsburgh as components of a single geographic region. Factories provide the communities with nearly 120,000 jobs, half of which are with steel companies.

Originally the Mahoning Valley was a transport corridor between Pittsburgh and Cleveland. In fact, a small canal was built through here in the 1830's, and coal mined in Youngstown was barged to Cleveland. With the discovery of nodules of iron in the sedimentary rocks of the vicinity came an influx of industry whose demands exceeded the capacity of the little canal; simultaneously, railroads were constructed to haul the added traffic. The canal went into disrepair, never to be revived. Sporadic bursts of enthusiasm indicate that an improvement program has not been forgotten. In 1898 the several independent steel companies began merging to form the large syndicates.

Today the mills are strung along the Mahoning Valley at intervals for 15 miles, from Lowellville to Niles. The ten miles of the river's length through Youngstown is an almost uninterrupted line of steel mills. Small tributary valleys contain the metal fabricating plants which consume some of the steel produced. Because not more than 10 per cent of this area's steel is consumed within its own boundaries, this district faces severe handicaps in (a) competing in market areas for sale of 90 per cent of its steel and (b) in assembly costs of materials (79). Most of its steel is sold elsewhere in Ohio, Pennsylvania, and Michigan, within reach of mills more advantageously located than the Mahoning-Shenango valleys. This poses a serious problem, since the area's economy is based so heavily on a single industry, a primary industry which frequently suffers acutely during general economic recessions.

Cleveland. Cleveland is America's eighth largest manufacturing center. Again, the main location for factories is in valleys, especially the Cuyahoga and Big Creek, both of which wind through the city toward Lake Erie. The concentration of steel mills on these valley flats illustrates the power of site factors in overcoming other obstacles. These mills are fed iron ore by lake ore carriers, which wind upstream around the tortuous curves of the river. Bluffs rising more than 100 feet at the lake's edge prohibited the location of steel mills there. Secondary factories making machinery, automotive equipment, fabricated metals, and chemicals, are not necessarily concentrated in valleys but are also found on the uplands.

Cleveland should be remembered foremost as a machinery producer, especially electrical equipment and machine tools (Maps 2.4, 2.15). Cleveland is one of the nation's largest machine tool producers, and the various associations of machine tool manufacturers generally hold their conventions and exhibits here. Located almost exactly in the center of the nation's main market and machinery belt, Cleveland is in an ideal location for making the machine tools required by machinery producers. The Warner-Swasey Company, one of America's leading machine tool producers, is a Cleveland concern.

Other centers. Other industrial centers are almost all smaller versions of the larger industrial types already discussed and are the products of similar factors. Canton (60,000), Lorain (30,000), and Johnstown (20,000) are almost identical to Pittsburgh in the dominance of primary metals, machinery and fabricated metals (71). Erie (50,000), a counterpart of Cleveland, is a machinery producer. Wheeling-Steubenville (53,000) resembles Pittsburgh, especially in the production of glass products. Akron, situated astride the Cuyahoga Valley 20 miles south of Cleveland, has a different manufactural structure than the average city in this region. With no original local iron ore to stimulate a steel industry, and being removed from direct access to lake carriers, it is not surprising that Akron developed no primary steel. Secondary metal fabricators and machinery unite Akron with the other manufacturing areas of this region, but the rubber industry predominates, providing jobs for 40,000 of Akron's 82,000 factory employees. Rarely does so large an industrialized city have nearly 50 per cent of its factory labor force in one industry.

The development of the rubber industry in

Akron reflects the predominant role of the market factor in determining the location of certain types of manufacturing. Harvested from plantations mostly in southeast Asia, the raw rubber is received at American ports and, without further processing, is forwarded to the main manufacturing belt, where, somewhere within the nation's main market, the rubber industry was certain to develop. That Akron was the specific location resulted from the influence of energetic local men who invented a process and risked capital on its development. Today one-fourth of the nation's rubber industry is in this one settlement.

Great Kanawha Valley

The Kanawha Valley in central West Virginia, extending from Gauley Bridge on the east to Nitro on the west, is the most recently developed major industrial concentration in northeastern United States (41). It remained an area of little industrial importance until the Chesapeake and Ohio opened a rail route from the Ohio River to Charleston in 1873. Manufacturing developed gradually in the valley until World War I, when the chemical industry gained greatly, setting the subsequent pattern for valley industry in general. The growth of chemicals was encouraged by the availability of significant raw materials: natural gas, bituminous coal, salt, petroleum, and vitreous clay. The industry was also aided by the presence of water and hydroelectric power.

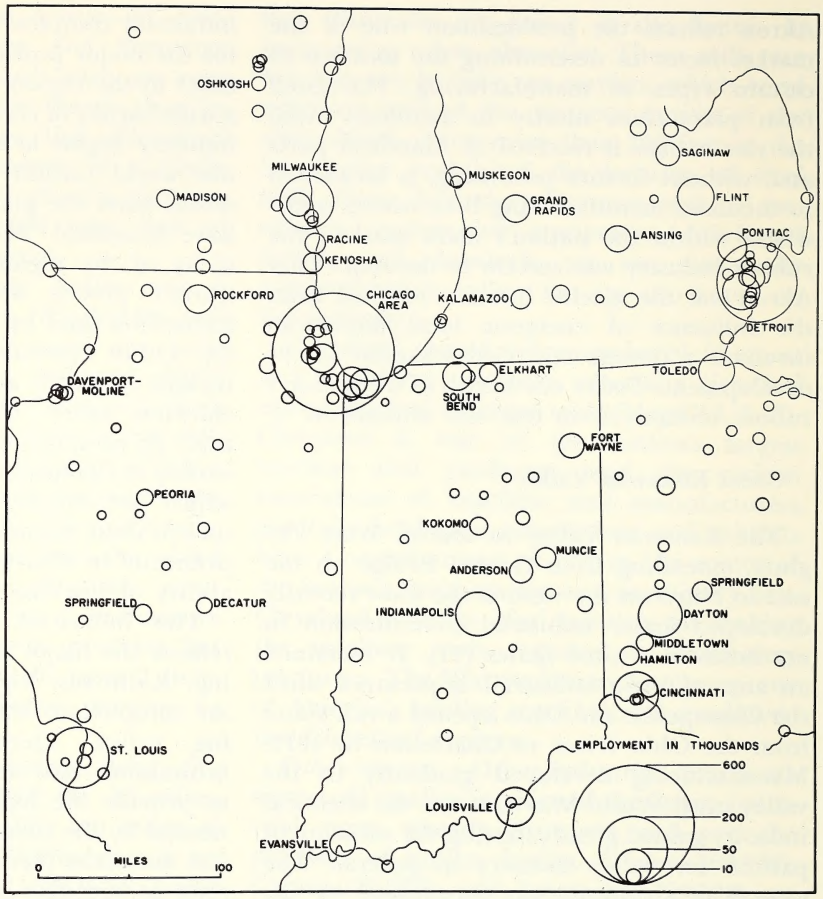
Whereas raw materials were widely distributed in West Virginia, precise localization of manufacturing was determined by the major transportation route across the state for the assembly of raw materials and dispersal of finished products. Transportation facilities are well developed. They include railroads, highways, pipelines and river barges. With the growth of the chemical industry it is no longer primarily dependent on local raw materials. In recent years the availability of workers skilled in the chemical industries, an economic structure conducive to expansion of chemicals, the presence of large established plants, and developed markets have been the main attracting forces.

The chemical industry has developed an industrial complex and continues to account for the major portion of output and employment in the region. The valley now produces a wide variety of chemical products. The nylon industry began here where a large share of the world output is still concentrated. In recent years the plastic and rubber industries have flourished. Ferroalloys are another specialty of the region, and the plants of this district process about one-quarter of the ferroalloys used by the American steel industry. Other chemicals produced in the area include sulphuric acid, caustic soda, ammonia, chlorine, ether, ethylene and hydrochloric acid. By-product coke ovens produce a wide variety of chemical raw materials. A few plants which are outside the chemical industries, such as those manufacturing glass, have located primarily in Charleston because of the availability of low-cost fuels.

The industrial landscape of the valley reflects the major importance of manufacturing. Railroads, highways and river facilities are conspicuous features of the narrow, winding valley. Electrical installations using bituminous coal are located within the area to provide the huge quantities of electricity needed by the chemical industries. The chemical industries themselves are strung along the river at irregular intervals, wherever space in the narrow valley bottom permits. Throughout the valley there is a continuous impression of industrial congestion. Little of the bottom land remains free from industrial development and its allied urban agglomerations. The industrial activity is concentrated in Kanawha County, where one-eighth of West Virginia's population resides, and of this number one-third is situated in Charleston, the major financial and commercial capital of the region.

Southeastern Michigan Industrial Region

The five midwestern states designated East North Central by the U.S. Census (Ohio, Michigan, Indiana, Illinois, and Wisconsin) in many ways have become the industrial heart of the nation (Map 2.11). Prior to World War II the census Middle Atlantic Region (New York, Pennsylvania, and New Jersey) had been the leader, although by 1939 its manufactural payroll had almost been



2.11. United States—Location of Manufacturing in the Middle West.

equalled by that in the East North Central Region. Between 1939 and 1958 the East North Central area grew more rapidly and finally overtook the Middle Atlantic area as indicated below.

This expansion in the Midwest represents essentially the growth of the larger cities, beginning with Cleveland at the east and including Toledo, Detroit, Chicago, and Milwaukee. Thus, the discussion of Cleveland, Akron, Canton and Erie in the foregoing chapter concerned the first of several midwestern areas which have experienced major industrial increments. Because of this relative growth the East North Central Region is significant.

A second reason for its significance is the problem it poses for regional subdivision. Clearly the five states do not present a uniform pattern of manufacturing. Such places as Detroit, Chicago, and southwestern Ohio stand out conspicuously. And yet the spaces between these places have considerable manufacturing, making the pattern rather continuous through northern Ohio, southern Michigan, northern Indiana, and neighboring portions of Illinois and Wisconsin. Consequently, any construction of regional boundaries will have to cut

Employment in Manufacturing

Census region	*Per cent of U. S. total 1939*	*Relative growth in per cent 1939-1958*	*Per cent of U. S. total 1958*
East North Central	28.2	56.9	26.5
Middle Atlantic	28.8	49.5	25.9

TABLE 2.12

Relative Increase in Manufactural Employment in Large Centers of the Main Manufacturing Belt, 1939-1958

West	*Per cent increase*	*East*	*Per cent increase*
Cleveland	50	Springfield-Holyoke	54
Akron	57	Hartford	128
Canton	57	Boston	55
Columbus	97	Providence	18
Dayton	98	New York	65
Toledo	53	Philadelphia	37
Detroit	26	Baltimore	56
Indianapolis	92	Pittsburgh	39
Chicago	40	Buffalo	50
Milwaukee	95		

Source: Statistical Abstract of the United States, U.S. Department of Commerce, Washington, D.C.

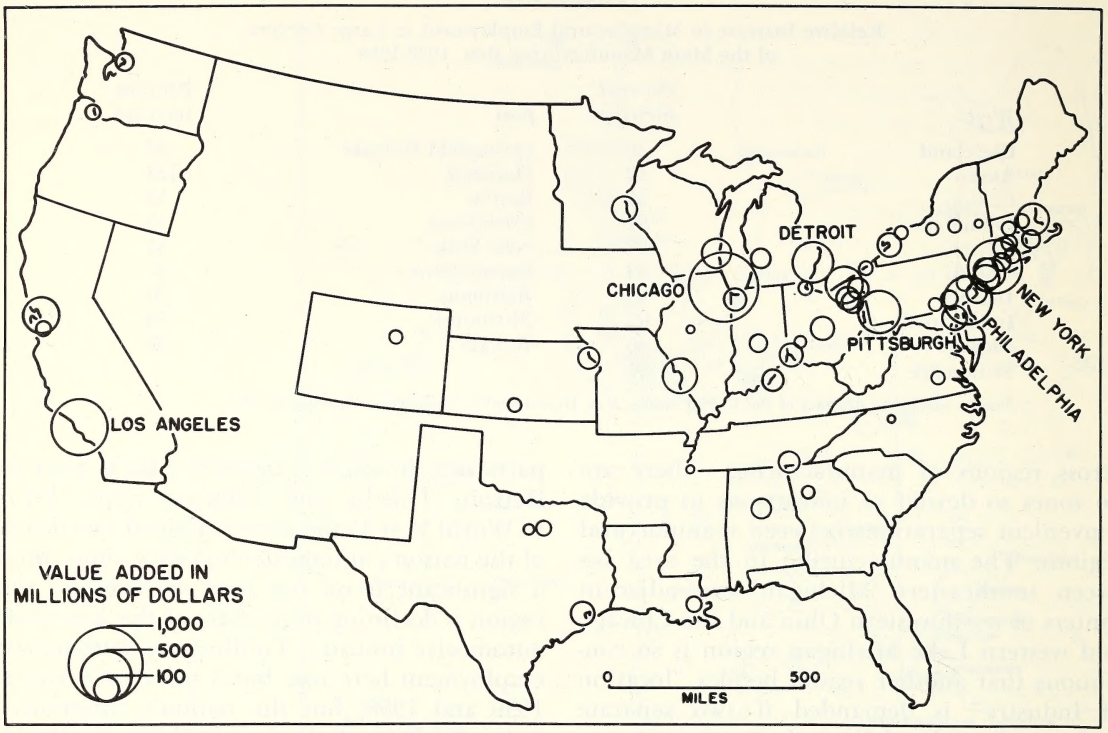
across regions of manufacturing. There are no zones so devoid of industry as to provide convenient separations between manufactural regions. The manufacturing in the area between southeastern Michigan and adjacent centers of northwestern Ohio and the Chicago and western Lake Michigan region is so continuous that another reason besides "location of industry" is demanded if two separate regions are to be delimited.

Two major factors justify the division of this area: southeastern Michigan's economy is related to Detroit, while the regional economic capital of southwestern Michigan, northern Illinois, and southeastern Wisconsin is Chicago; secondly, southeastern Michigan and neighboring Ohio manufacturing is dominated by automotive production, whereas little of this appears in the Chicago area (Map 2.14). The one industry uniting them is machinery; this is a continuation of America's machinery belt (Map 2.15).

Industrial structure. The production of automobiles and parts is so important in this region's economy, and this region is so important in the national pattern of that industry that the regional discussion of manufacturing in this instance would require repetition of much that is observed in Chapter 10, "Motor Vehicle Industry." For that reason the reader will be reminded of only a few major points. From the inception of mass production methods, the automotive industry has been one of the most highly concentrated of American industries. Most of the factories producing parts and those assembling these parts into finished automobiles have been in Detroit, Toledo, and tributary cities. Prior to World War II the area contained two-thirds of the nation's automotive industry. Since then a significant trend has been discernible: the region is declining in its share of the American automotive industry. To illustrate, automotive employment here rose but 5 per cent between 1939 and 1958; but the nation's automotive industry as a whole increased by nearly 15 per cent. Clearly, the industry was expanding more rapidly in other places, to shrink this area's share from 66 per cent to 56 per cent. The change results from the response of building new assembly plants in market areas. Fabrication of automotive parts is still concentrated in the automobile belt, but more and more of them are being shipped in truck and carload lots to assembly plants dispersed throughout the nation, resulting in lower aggregate costs of delivering assembled automobiles to distributing dealers.

The Detroit metropolitan area has about 467,000 manufactural employees. This makes it one of the largest manufacturing centers of the nation. The physical setting is different from that of any major center so far discussed. Its site is not threaded by numerous navigable waterways providing miles of waterfront sites, as in New York and Philadelphia; its terrain is flat, in contrast to the hills and valleys of Pittsburgh and Cleveland; its water frontage is lowland so that heavy industry can be located directly on the water's edge.

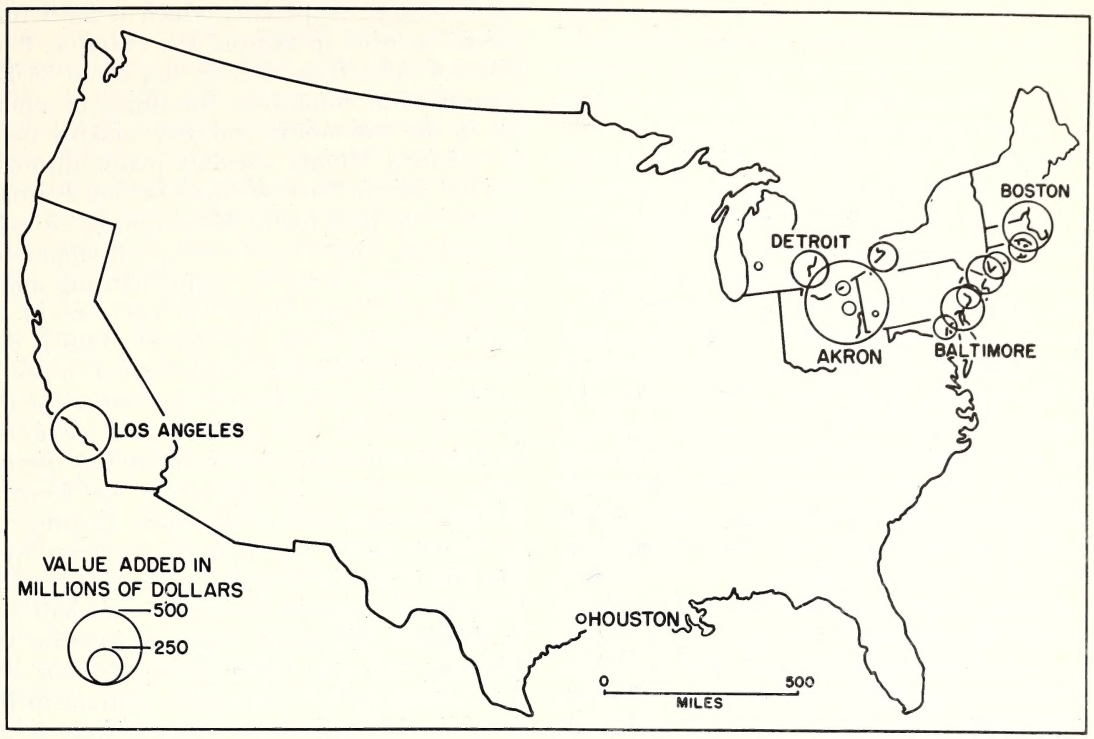
The strategic location of this site cannot be overemphasized. It is not only on the main



2.12. United States—Fabricated Metal Products—1958.

route of Great Lakes traffic for coal, ore, and limestone but also located near the center of the nation's northeast quadrant, which is the major belt of purchasing power and manufacturing. It would seem that Toledo's position would be more advantageous than Detroit's in terms of shortest railroad and highway routes to this major market. The factors explaining Detroit's great development are essentially those explaining the auto industry's locating here. It would be interesting to speculate on how much industry Detroit would have today if this locality, without a natural harbor, had not received the benefit of the inventive genius of Henry Ford, Olds and others who launched Detroit's automobile industry.

Pattern of manufacturing. The pattern of manufacturing in Detroit is essentially that of a semicircular belt around the central focus. In the central area is located some industry of the type found in every city, such as printing establishments, bakeries, and ice cream factories. But their aggregate represents less than a tenth of the area's manufacturing, in clear contrast to the pattern in New York and Philadelphia, where the magnitude of apparel production lures thousands of workers to downtown "loft buildings," or the pattern in Youngstown, Pittsburgh, and Cleveland, where deep valleys provide sites for heavy industry near the city center. Most of Greater Detroit's production is in a belt which can be said to begin at Wyandotte and Ecorse at the south, curving around through Dearborn, Highland Park and Hamtramck and including contiguous portions of municipal Detroit. Heavy manufacturing is at the south of this arc, fronting the Detroit River. The three blast furnaces of the Great Lakes Steel Company at Ecorse have an annual capacity of over one million tons. Their furnace stacks and gas ovens are one of the most conspicuous features on the landscape as one approaches Detroit from Canada over the Ambassador Bridge. Serving a large steel market in their immediate vicinity and located as close as possible to cheap water transport of raw materials, these steel mills are in an unusually favorable position. There is



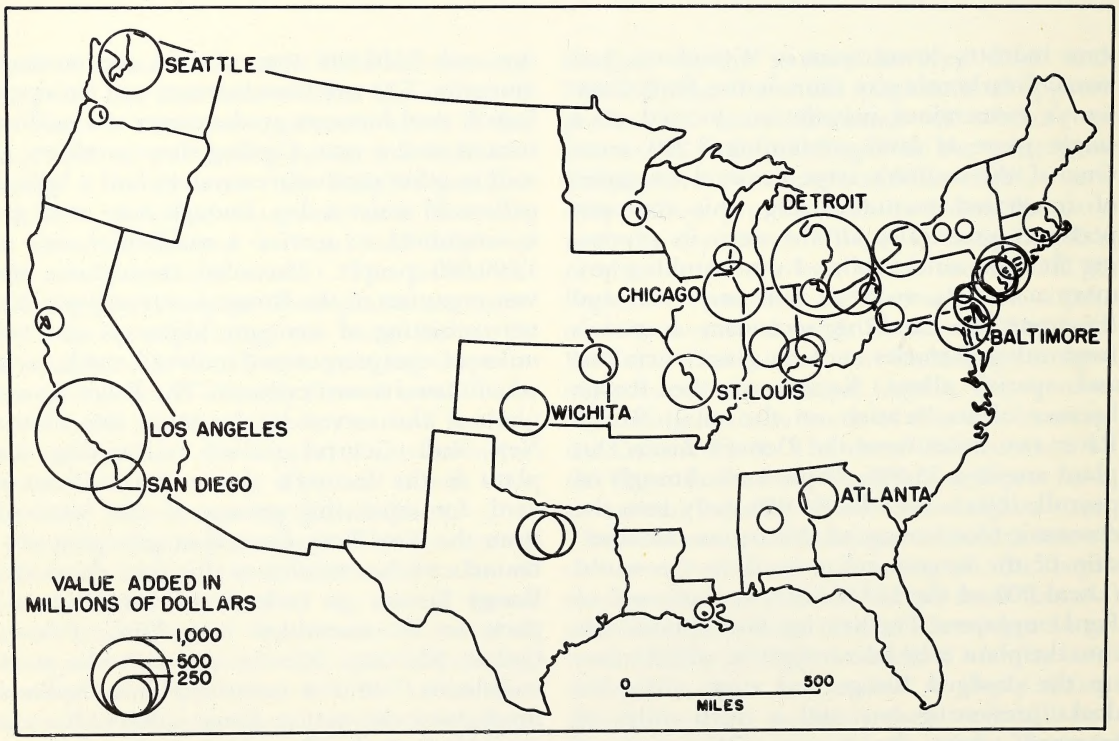
2.13. United States—Rubber Industry—1958.

some industry downstream in Wyandotte. Just across Dearborn's city limit is the Ford Company's tremendous installation, located on a single piece of land containing 1,200 acres. One of the nation's most unusual examples of integrated manufacturing, this company performs practically all the steps in processing finished automobiles, from handling primary materials, such as iron ore, coal, and limestone to handling secondary materials from other factories such as glass, chemicals and special alloys. Known as the Rouge because of its location on the small Rouge River two miles from the Detroit River, this plant employs 75,000 people and, through its payroll, injects over $1,000,000 daily into the economic bloodstream of this region. Membership of the largest union local in the world (Local 600 of the UAW-CIO) is composed of Ford employees. The heaviest flow of materials into the plant is by lake freighters, which move up the dredged Rouge and come alongside docks presenting one and a third miles of frontage, where almost one million tons of ore and 2,500,000 tons of coal are received annually. The two blast furnaces and ten open-hearth steel furnaces produce over one million tons of steel a year. Cooling these products, as well as other products, consumes half a billion gallons of water a day. Enough coke oven gas is consumed to service a residential city of 1,500,000 people. Threaded throughout the vast organism of the Rouge is a transportation net consisting of company highways and 100 miles of company-owned railroad track, over which runs its own railroad. The River Rouge plant is also served by the main line of the New York Central railway. Adjoining the plant is the factory's own rail classification yard, for separating groups of cars received from the New York Central or grouping outbound cars for transfer to this line. From the Rouge factory go carloads of manufactured parts to be assembled into Ford, Falcon, Comet, Mercury, Meteor, and Lincoln automobiles in 17 branch assembly plants dispersed throughout the nation. Some automobiles are assembled at the Rouge plant for delivery,

mostly by autocarrier highway trucks, to Michigan dealers. The epitome of mass production, this factory led the way into a new industrial era for not only the automotive industry but for all phases of manufacturing.

Completing the industrial arc around Detroit are numerous sites featuring the factories of Cadillac, Chrysler, Dodge, Plymouth, and others in which assembled cars and automotive parts are produced. None of these manufacture their own coke, pig iron or steel, but all of them produce the parts which distinguish their models, and many job-out certain steps in the process. One type of jobbing-out is sending materials to foundries, machine shops, and other Detroit fabricators who, producing almost entirely for the automotive companies, play integral roles in the functioning of that industry—although they are officially separate, in terms of name of company.

A second type of jobbing-out is the sending of materials to other Michigan cities whose economy is as integrated with that of Detroit as the Detroit sub-fabricators are with the Detroit auto companies. Each of several cities, has developed a specialty which it feeds into parent factories in Detroit. For example, Pontiac, ten miles from Detroit, has about 35,000 manufactural employees, two-thirds of whom are in the automotive industry, making parts for General Motors assembly plants throughout the nation. Flint, 60 miles beyond Pontiac, is one of the most highly industrialized cities in the nation, with 55 per cent of all employees being accounted for by manufacturing and—even more unusual—with 90 per cent of its manufacturing being automotive. This is one of the best examples in the United States of a one-industry city. Flint is the center for the General Motors Corporation and assembles both Chevrolets and Buicks as well as specializing in engine manufacturing for General Motors assembly plants elsewhere. Lansing has two-thirds of its 25,000 industrial employees producing automobiles and parts, mostly Oldsmobiles; in Ypsilanti the ratio is one-half and in Saginaw, one-third. This emphasis on the industry that has made Detroit famous and by which southeast Michigan's manufacturing is connected organically with Detroit is the



2.14. United States—Transportation Equipment Industry—1958.

region's unifying characteristic. Between these cities shuttle trucks loaded with parts for assembly into automobiles. Out of this region flows a steady procession of railroad cars loaded with frames, engines, transmission systems, wheels, and seats, destined for distant assembly plants throughout the country. Some of the rail flow comprises assembled automobiles, although the proportion is decreasing. Some automobiles are shipped via the Great Lakes east to Buffalo and to northern ports, but most of the finished cars move by road in groups of four, straddling two-decker auto-carrying trucks. The frequency of the movement of these carriers over the highways of southern Michigan makes the transportational geography of this region unique.

Although there is emphasis on automobile production in the Detroit region, it would be fallacious to infer that other industries are insignificant. Detroit is one of the nation's leading machinery centers. The emphasis is not so much on electrical machines as upon machine tools and automotive equipment, pumps, compressors, and the wide array of machines used by an industrialized nation. Detroit produces more primary metals than Cleveland or Philadelphia, more fabricated metal goods even than Pittsburgh. Clearly, Detroit's factories have concentrated on metallic goods—and yet there are nearly 60,000 people in such factories as food processing, printing and publishing, and chemicals. When an area becomes dominant in one industry it tends to generate a market which then attracts factories producing nearly the complete gamut of consumer goods production.

Lake Michigan Hinterland

Chicago is the key point of the nation's second largest concentration of manufacturing, a region difficult to delimit. When Chicago is viewed as the focal point of this area, manufacturing is distributed outward considerable distances to include southeastern Wisconsin, northern Illinois, northern Indiana, and western Michigan. These four portions are unified as a manufactural region by the predominance of one product: machinery. This is the machinery heart of the nation.

There are 1,500,000 employees in the factories of this area. It is to be distinguished further by its recent growth. Here is one of the most rapidly growing industrial districts in the nation. This does not imply that the nation's fastest growing counties are here; but it does indicate that when numerous contiguous counties spread over extensive territory, rather than segregated individual counties, are considered, this region in terms of recent manufactural growth is America's leader.

Chicago. Almost a million people earn their living in manufacturing in the Chicago metropolitan area. As defined by the census, this area includes six Illinois counties (Cook, DuPage, Will, Lake, McHenry and Kane), plus Indiana's Lake and Porter counties. It is this group of counties, represented by the single large circle on Map 2.11, which ranks second only to Metropolitan New York in American concentration of industry. In terms of size alone, Chicago's industry is worthy of considerable attention. Moreover, the Chicago industrial area is expanding rapidly.

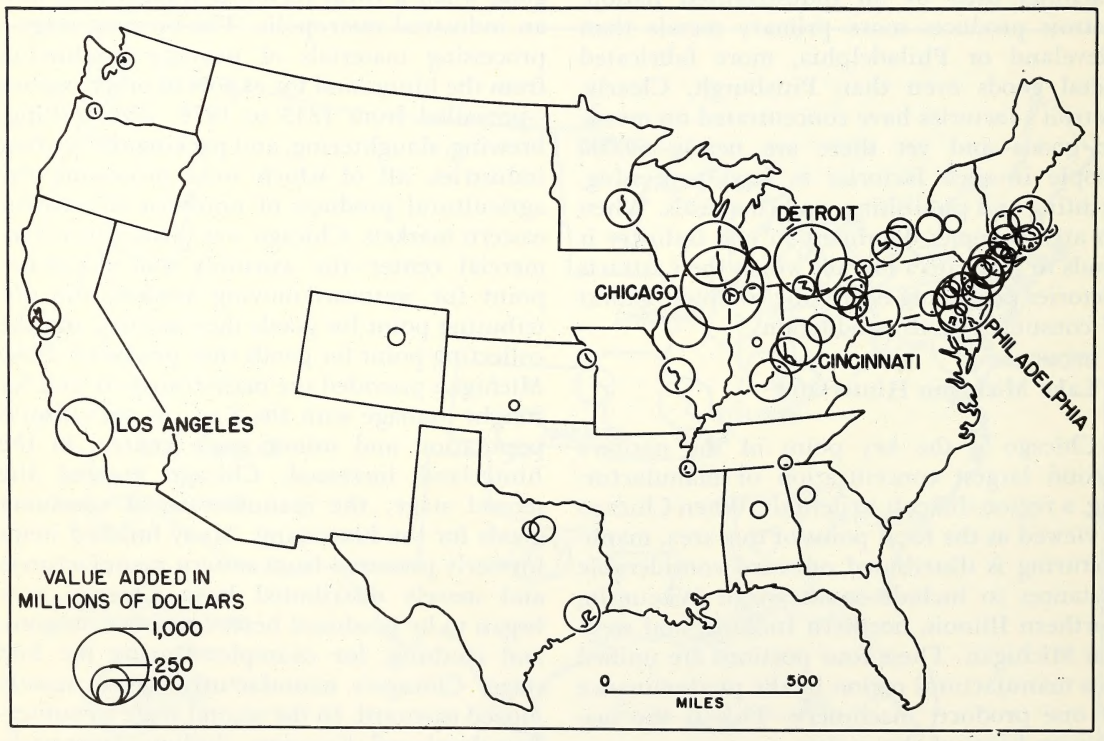
Industrial structure. Chicago's manufactural history illustrates the usual stages undergone when a rural region is transformed into an industrial metropolis. The opening stage—processing materials of primary production from the hinterland for export to other regions—prevailed from 1833 to 1878, with milling, brewing, slaughtering, and packing the leading industries, all of which were processing the agricultural products of northern Illinois for eastern markets. Chicago was primarily a commercial center—the assembly and departure point for westward-moving settlers, the distributing point for goods they needed, and the collecting point for goods they produced. Lake Michigan provided the main transport link for freight tonnage with the East. As agricultural population and minor trade centers in the hinterland increased, Chicago entered the second stage: the manufacture of consumer goods for the hinterland. Many finished items formerly procured from eastern manufacturers and merely distributed from Chicago now began to be produced here: furniture, wagons, and clothing, for example. During the first stage, Chicago's manufactured goods mostly moved eastward. In the second stage a counter-flow developed. For years, clothing, meat-packing, and furniture were "The Big Three" of

Chicago's manufacturing. In the third stage, Chicago factories reached national importance, sending to a national market goods made out of materials drawn from distant sources. This stage also is typified by the manufacture of producer goods--those required by other factories in making other goods. The presence of iron and steel mills and machinery factories marked Chicago's evolution to the third stage. By 1914 "The Big Three" had been surpassed by iron and steel. Maturing Chicago has advanced further by making machinery not only for her own factories but also for export to other regions. Chicago has reached the most complex machinery stage with the manufacture of machine tools, the equipment with which machines themselves are made.

Today, machinery is Chicago's leading industry and Chicago is America's leading machinery producer. More than 250,000 people are employed in Chicago's machinery factories. Almost half of this is represented by producers of electrical machines. Communication equipment, such as telephone devices, tubes, radios, transmitters, and recording instruments, is today Chicago's most distinctive kind of machinery. Although agricultural machinery was once the most important, its position has declined, and the production of tractors, harvesters, drills, and harrows now employs only about 20,000 people. There is no point in enumerating the many other kinds of machines produced; the main point is that here is found the most varied aggregation of machinery factories in the world. Not only in totality of effort but in diversity of product as well, Chicago is the heart of the nation's machinery industry. Within Chicago, machinery factories are dispersed throughout many industrial areas.

Of second rank in Chicago are primary metals. Only in Pittsburgh do blast furnaces, steel mills, and foundries provide more jobs than Chicago's figure of 125,000. In contrast to Chicago's machinery pattern, the heavy metals industries are concentrated in one area of the city, the far southeastern.

Food factories employ nearly 100,000 mostly



2.15. United States—Machinery (except electrical machinery) Industry—1958.

in meat-packing, candy making, and baking. Chicago was long the nation's leader in the first of these. Yet a significant trend in the meat-packing industry has seen Chicago's leadership gradually dwindle from a World War I peak. New packing centers to the west and southwest, particularly East St. Louis, Kansas City, Omaha, Sioux City, and St. Paul are rapidly overtaking Chicago, essentially because of proximity to raw material regions—in this instance the cattle and hog belts, which produce a commodity that loses weight enroute to factories. Perfection of refrigeration enables these new centers to serve the eastern markets.

Fabricated metal goods—the diverse collection of secondary metal products which do not qualify as machinery or transportation equipment—have developed concomitantly with primary metals. These fabricating plants, making such items as tin cans, hardware, heating and plumbing fixtures, structural metal items, stampings, wire fence, pipe, nails, bolts, and screws had taken root in Chicago before the steel mills came. They, along with the machinery factories, comprised a steel market, supplied at first by steel from eastern sources, principally Pittsburgh. It was the rapid increase in the consumption of steel by these many fabricators and machinery factories which made it advantageous to establish blast furnaces and steel mills in the Chicago area.

One other group of industries is important in Chicago: printing and publishing. In the highly literate parts of the world, it appears that cities which function as large regional centers invariably develop extensive printing and publishing industries. Machinery, primary metals, secondary metals, textiles, apparel, automobiles, and aircraft: these vary markedly from place to place. But printing seems to be rather well distributed, generally in proportion to population, therefore deserving of the term ubiquitous. Thus, it is not surprising that Chicago is exceeded only by New York in this industry. Printing of daily newspapers in Chicago requires a labor force of about 13,000 workers. Most of Chicago's effort however is contract work such as catalogs, phone directories, advertising circulars, and some books.

The tendency in analyzing the industrial structure of manufactural centers is to emphasize industries which are conspicuous or distinctive at the expense of others which may be almost as important in the region's economy. For instance, the five leaders just discussed comprise two-thirds of Chicago's industry; over 300,000 additional jobs, which alone would mark Chicago as a sizable manufacturing center, exist in several other kinds of factories. Commenting on each becomes tedious, but it can be noted that Chicago also has 35,000 people manufacturing clothing; over 40,000 producing railroad cars, locomotives, and automobiles; almost 40,000 making chemicals; 15,000 refining petroleum and its products; and 25,000 making paper products. It should be emphasized that the large centers of industry such as New York, Chicago, Detroit, Philadelphia, Pittsburgh, and Los Angeles tend to develop both consumer and producer goods industries.

Pattern of manufacturing. The pattern of industry in Chicago clearly reflects a locational principle: in urban areas factory belts tend to develop along existing transport arteries (32). In a few instances industry occupies Lake Michigan frontage, especially on the sandy sites at the southern end of the lake. Several factories are located along the lake north of Waukegan. By and large however, land fronting on Lake Michigan is devoted to parks and residential or commercial uses. Most manufacturing in the Chicago area is inland along canals and railroads. The pattern is one which radiates outward in all directions for six or seven miles from the commercial core. Beyond that however, a sharp contrast distinguishes northern Chicago, with little industry, from western Chicago with a mixture of light and heavy industry, and southern Chicago, which has predominantly heavy manufacturing.

Within the commercial core, light industries are typical. Many of Chicago's clothing factories are here, although its size nowhere approaches that of the apparel industries in downtown New York or Philadelphia. Yet the same type of relationship is discernible in the use of buildings: first floor devoted to several retail and wholesale outlets for different types of clothing, and upper floors devoted to factory operations.

Outward from the central area, small machinery and electrical equipment factories be-

come numerous. Large printers such as Lakeside Press of the Donnelly Company and the Cuneo Press are on the near south side; Florsheim Shoe, bakeries, candy makers, and numerous metal fabricators are on the near west side. One advantage of factories in this inner belt is proximity to both railroad freight terminals and truck terminals. The inner portion of Chicago, in contrast to New York, has considerable land occupied by railroads, much of it comprising freight terminal facilities. An intricate network of rail switching routes and belt lines connects the terminals with factory sites in the inner industrial belts.

The North Branch area extends along the Chicago River in a shallow valley occupied by two important transport arteries: The Chicago and Northwestern Railway and Elston Avenue. An almost continuous belt of light and semi-heavy industry extends for nearly seven miles northwestward, tapering off into isolated clusters of small factories. This is one of Chicago's machinery belts.

Southwestward from the city's center is the longest and widest industrial zone in Chicago. Flat land along the South Branch of the Chicago River has constituted satisfactory land sites fronting on first the dredged river and then the navigable Sanitary and Ship Canal, linking Lake Michigan with the Illinois-Mississippi river systems, several main-line railroads (Santa Fe, Gulf, Mobile and Ohio, Illinois Central, and several switching lines), and U.S. Highway 66 to the southwest. Heavy industries, such as electric power plants, numerous machinery companies, and many smaller factories are here.

The Stockyards area is distinctive not only for its dominant industry but also for the way it began. In the mid-1800's Chicago's meatpacking industry functioned in numerous isolated places: slaughtering houses were scattered in different areas, processing animals that were kept in many separate stockyards, each railroad having its own area of pens in which daily arrivals were kept, awaiting purchase by the packers. Rapid growth of the industry convinced both railroads and packers of the advantages in a centralized location. In 1865 the Union Stockyards Company was formed by both railroads and packing interests; more than a square mile of land was purchased "outside the city" for construction of all facilities for assembling, keeping, selling, and slaughtering the animals. Armour and Company and Swift and Company are the predominant firms. About 30,000 people earn their living here. Subsequent growth of the city has engulfed the stockyards and proceeded so far westward that one finds it difficult to realize they were once "out of town." The stockyards are distinctive as a type of planned industrial area where land was purchased and laid out and transport routes constructed according to a preconceived manufacturing plan. Fringing the stockyards on nearly all sides are factory concentrations including a wide variety of producers, in areas which are likewise distinctive as illustrating a type of planned industrial area.

The Central and Clearing districts southwest of the stockyards are two industrial areas which are significant from the standpoint of geography because they illustrate the operation of an unusual factor in the development of manufactural areas: the organized industrial district. Robert Wrigley has analyzed this phenomenon, which is found in a few larger cities but nowhere has functioned so widely as in Chicago. According to Wrigley, (92)

> In the United States there are only a few organized industrial districts of any note. The Kansas City area has two important districts . . . the Fairfax Industrial District, developed and controlled by the Union Pacific Railroad Company, and the North Kansas City Industrial District. In Minneapolis the Northwest Terminal Company has developed an outstanding industrial subdivision. In Los Angeles a large industrial tract, promoted by the Central Manufacturing District of Chicago, now is controlled by the Atchison, Topeka and Santa Fe Railroad Company. In the Chicago area, however, the scientific planning of industrial land use in the United States has reached its greatest development. Here an industrial real estate firm, the J. H. Van Vlissingen Company, has promoted the Kenwood Manufacturing District and other developments on land owned by the Phipps Industrial Land Trust. But the pioneers and foremost promoters of organized industrial areas in the Chicago region and in the United States are the Central Manufacturing District and Clearing Industrial District.
>
> Both the Central Manufacturing District and the Clearing Industrial District have promoted

several industrial tracts in the Chicago area. All Central District projects are located in the southern half of Chicago with the two original developments near the city's geographic center.

The success of the Central and the Clearing endeavors in developing planned industrial areas illustrates what can be done when private planning groups and city planning agencies collaborate. In this kind of development Chicago is particularly distinguished.

Several belt line industrial areas extend almost at right angles to North Branch, the New West Side, and the South Branch areas, all of which have radial patterns out from Chicago's core. One of these extends nearly ten miles from the Montrose node at the north along the Chicago and Northwestern's belt line southward through the Cragin and Hawthorne areas to South Branch. Another paralleling belt occurs three miles to the east, flanking the belt line. Similar types of industrial concentrations occur on the south side. The locational principles operating in these belt line areas are essentially those operative in the planned industrial districts. These principles include industries moving out from inner portions of the city, newly organized local companies, and some establishments from other communities in search of more industrial land having transport services. The only difference is that most of these belt line areas were not planned as completely as or with the foresight of the Central and Clearing districts. The gradual expansion of both belt line and radial industrial areas across Chicago's city limits into the suburbs is evident in many places.

The southeastern industrial area is distinctive for several reasons: heavy industries predominate, water transportation is important, and industry has developed on reclaimed land. The physical setting originally was flat, sandy, marshy, and poorly drained, the former bottom of Lake Michigan. Lake Calumet and Wolf Lake are the largest of several swamps which flank the Illinois-Indiana state line. Hundreds of acres have been reclaimed by filling these swamps; the artificially straight northern shore of Lake Calumet represents encroachment of "fill." Long-range plans of the City Planning Commission call for construction of land on most of this lake's area, leaving a carefully defined network of navigable channels. Similar reclamation efforts have produced building sites along the Calumet River, Wolf Lake, Sag Channel, and even Lake Michigan itself.

Extensive dredging has not only improved drainage but also provided water transport arteries. Barges moving up the Mississippi and Illinois rivers use the Sag Channel, which connects with the Calumet River. Smaller lake vessels serve factories along the Calumet River and in time will serve those on Lake Calumet itself. Large lake freighters dock alongside plants fronting Lake Michigan. This area is also favorably situated for railroad transportation. Main-line railroads to the east—the Pennsylvania, New York Central, Nickelplate, Baltimore and Ohio, Chesapeake and Ohio, and Erie—go through the heart of this territory. Moreover most of their freight classification yards are here, giving these factories proximity to the facilities which sort freight cars.

Heavy industries typify this area, which in turn is Chicago's main concentration of heavy fabrication. Steel mills, petroleum refineries, and chemical processors are most conspicuous. Within a twelve-mile stretch along the Lake Michigan waterfront from the mouth of the Calumet River to Gary there is one of the most spectacular concentrations of blast furnaces and steel mills in the world. In no other comparable space are there so many large steel mills nor as much steel production. Over 20 per cent of America's steel is produced in this short segment of land. Even Pittsburgh and its suburbs fall short of this figure. The Ruhr, with mills and production greater than any other area in Europe, has smaller mills and less steel output than the string of factories which one sees from a train window in the few brief minutes required to travel the twelve miles from south Chicago to Gary.

Rather late in arriving on the Chicago scene, blast furnaces and steel mills were established on the unoccupied land at the southern end of Lake Michigan where expansive sandy wastes constituted cheap land, where flat topography allowed open room for growth, and where lake carriers could dock alongside the establishments. On such a site, located in the center of the Midwest steel market, the United

States Steel Company in 1906 constructed the largest and most efficiently arranged steel works in the world. The new factory was named in honor of the steel company's chairman, Judge Elbert H. Gary. Immediately, urban settlement took root on the sandy wastes south of the factory. The resultant city also was named Gary. Its economy is based heavily upon the steel industry.

Petroleum refineries and nests of huge storage tanks extend for five or more miles south of Lake Michigan. With Whiting, Indiana the focal point, this is the largest inland refining area in the world. Petroleum arrives by pipe and barge from southern United States and is shipped by pipeline, tank car, and tank truck to the midwestern market. Some refinery products move by barge into the Great Lakes system. Standard and Cities Service companies operate the larger plants.

Chemical industries secondary to steel and petroleum are based partly on processing the products and by-products from these factories. Yet many process directly raw sulphur, limestone, and other primary raw materials. The Sherwin-Williams paint factory west of Lake Calumet is one of the largest factories here.

Also just west of Lake Calumet is an industrial settlement which, like Gary, was for many years locationally independent of Chicago. Pullman is a company town based on the Pullman Company's railroad car shops. The subsequent growth of Metropolitan Chicago has engulfed these settlements, and the casual tourist drives through them without realizing the significance of their industries.

Yet for all the emphasis on heavy manufacturing in the southeastern area, lighter industries are not absent. Tool companies, machine factories, and a host of diversified producers are springing up in this area, one of the most intensively industrialized portions of the world.

Deconcentration of manufacturing. As is true for most manufacturing centers, Chicago's industrial pattern currently is experiencing a change. The growing emphasis of peripheral location of small factories not served by railways is a notable example. The fabulous development of American trucking has resulted in many plants being able to locate along highways at the edge of town.

The desirability of deconcentration of industry is a debatable issue. Many contend that from the standpoint of strategic protection and congestion manufacturing should be encouraged to spread out. This would require many factories to leave large cities and scatter throughout the suburbs. On the other hand, this deprives the central city of major components of its tax base. This centrifugal movement of manufacturing is a phenomenon in most large manufacturing cities. Older industries leave the city and new ones either originate or move in to take their places. Chicago is not unique in this respect.

Industrial recentralization, or the relocation of Chicago's industrial establishments from within the city proper to points outside Chicago's political boundaries, is not a particularly recent feature of the city's industrial economy. Decentralizing tendencies were in evidence as early as 1903 when the Western Electric Company moved from Chicago to Cicero. During the 11-year period 1925-1935, 127 manufacturing companies moved from Chicago to various points within the Chicago industrial area. The outward movement has continued and thus appears to be a continuous phenomenon of Chicago's industrial economy.

A number of factors appear significant in this industrial migration. In the relocation of Chicago's industries the initial plants established beyond the city limits are considerably larger than those locating inside the city. Furthermore the new and outside industries tend to expand more rapidly than those inside the city. There is also a tendency for the displacement of many of the city's medium-sized industries by small manufacturing plants. In the relocation of plants well over half of the new plants developing within the city migrate from points entirely outside the Chicago area; in contrast, about one-third of the plants locating in areas outside the city are concerns migrating from Chicago. Very few plants move from peripheral areas to the city of Chicago. The tendency for Chicago's relocated plants to cluster on the rim of the city and in nearby suburban localities is becoming increasingly evident. In fact, three-fourths of all relocated industries are found at points less than 15 miles from the Loop. On the other hand, nearly three-fourths of the new industries are

locating at points over 15 miles from the city's center. In general, the great majority of new industrial locations, both relocated and newly established, are made to the west and south of the city and within Cook County.

Milwaukee. Located 90 miles north of Chicago, Milwaukee has experienced a rapid expansion of manufacturing. Between 1939 and 1958, Milwaukee's industrial employment increased 45 per cent, Chicago's growth was 40 per cent, Buffalo's 50 per cent, Detroit's 26 per cent, New York's 65 per cent, Pittsburgh's, 39 per cent, and Philadelphia's 37 per cent. Milwaukee is almost tied with Buffalo as the twelfth-ranking manufacturing nucleus.

For all the publicity given the output of beer, Milwaukee is essentially a machinery maker. One of the largest factories in America is the Allis-Chalmers plant in West Allis, a western suburb that has been engulfed by Milwaukee's growth. With an employed labor force of 15,000 this one factory alone could probably support a city of 100,000. From this factory, which covers a land area nearly a mile long and half a mile wide, flows a broad line of machine products, tractors, and castings.

Secondary steel fabricators of such products as tanks, structural items, and tin cans are also important. The automotive industries make parts and bodies for the American Automobile Company, which assembles finished cars 20 miles to the south in Kenosha.

Beverage factories employ about 8,000 and have acquired a reputation out of proportion to their actual support of Milwaukee's employment structure. Milwaukee's breweries do not aggregate quite as much production as competitors in Greater New York; however the Schlitz establishment rates as the world's largest brewery.

Meat-packing, baking, leather, printing and nearly all major categories which characterize large industrial centers are present. With so much of its manufacturing comprising the processing of steel, Milwaukee is akin to New York in having an absence of primary iron and steel producers. Numerous foundries are present; machinery and fabricated steel centers generate large demands for castings. At one time Milwaukee did have a small iron and steel industry. This company was purchased by one of the nation's larger firms, operations were moved to Chicago, and the Milwaukee works were dismantled. Apparently steel companies have decided that it is more economical to ship steel 90 miles from large efficient mills in the Chicago area than to operate a small mill in Milwaukee.

Other centers. Grand Rapids, Michigan, has over 44,000 jobs in factories. Like Chicago and Milwaukee this is predominantly a machinery and metal goods producer. About 8,000 people work in furniture factories. Swedish and Dutch settlers transplanted the artistry of furniture making and, handing the skills down to succeeding generations, earned for Grand Rapids the reputation of being the nation's leading maker of premium brand furniture. For many years during the late 1800's and early 1900's furniture industries comprised the main portion of Grand Rapids' economic base. The rapid growth of America's metal goods industries has seen Grand Rapids, like so many industrial centers, undergo transformation.

South Bend, with about 34,000 industrial employees, is a major automotive center, and, using the criterion of type of manufacturing, could be classified with the Detroit and southeastern Michigan region. Rockford, Illinois, Racine and Kenosha, Wisconsin, and Muskegon, Michigan are the remaining conspicuous industrial centers of this region. Each is chiefly a machinery maker. Kalamazoo is an exception. A paper goods processor, Kalamazoo typifies the continuance of an industry based on the historical factor of an early beginning.

Southwestern Ohio-Eastern Indiana Region

In the triangle outlined by Cincinnati, Columbus, and Indianapolis, a major manufacturing complex has evolved (Map 2.11). Here in an agricultural setting, where the original towns and cities were primarily commercial, manufacturing has become important. Throughout most of the area the manufacturing centers are separated by prosperous farming land. The heart of the industrial concentration lies in the section from Cincinnati northward along the Miami Valley to Springfield, Ohio.

The localization of manufacturing in this

area reflects the importance of a central interior position. The Ohio River has provided an important passageway along the southern boundary of the region. Within the area there are few raw materials besides agricultural products to attract manufacturing. There is also little power directly within the borders of the area. However, the region is strategically situated between the heavy metallurgical centers of the Appalachians to the east and the large agricultural markets of the Midwest. This area originally concentrated on the production of products that had a local and regional market, but as skills increased, higher-valued products were produced for a national market. Manufacturing in the region has become highly skilled and diversified. The larger cities have much variety of product, whereas the smaller cities have tended to concentrate on certain specialties. With the maturing of the industrial economy, manufacturing has tended to resemble that of southwestern New England.

Cincinnati and the Miami Valley. In southwestern Ohio in the Miami Valley corridor lies a string of important cities with diversified industry. Cincinnati, the southern point of the axis, was the first city in the area to develop a major manufacturing concentration. In the early westward migration it grew as a supply point for pioneers who needed basic commodities before entering the frontier country. Of these products none were of greater importance than nonperishable food. Cincinnati's factories soon became the leading center west of the Alleghenies for curing, salting, and packing pork in barrels. Processing pork was the first major industry and Cincinnati maintained its supremacy as the "porkopolis" of the Midwest until after the Civil War. With the livestock industry's westward expansion new meat-packing cities such as Chicago and Omaha arose, and Cincinnati gradually lost its dominant position. Whereas the city still packs meat, soap production from available fats has fostered an important specialized chemical industry.

From the great variety of small shops that supplied the early settlers, Cincinnati has developed a highly diversified manufacturing economy. About one-third of the wage earners of the city are engaged in manufacturing. The metal product industries employ the largest number of workers (Map 2.15). Cincinnati is one of the oldest and most important of the machine tool producing centers in the nation. With the growth of the automobile industry the area supplied the early machine tool workers for the lower Great Lakes plants. Cincinnati, along with Cleveland, has a larger proportion of major machine tool plants than any other American city. Besides machine tools, other metal products are produced. Transportation equipment has long been important and today includes the manufacture of commercial trailers, aircraft engines, fire engines, and automotive bodies as well as parts. Complicated electrical equipment, requiring a highly skilled labor force, has thrived in recent years.

North of Cincinnati in the Miami Valley lie the important industrial cities of Hamilton, Middletown, Dayton, and Springfield. Manufacturing rose in this area after the completion of the Miami and Erie Canal in 1829. The industry, localized along that transportation route, began producing commodities that were consumed in the nearby prosperous farming region. Many of these pioneer industries are represented in the valley today. For example, the manufacture of woolen products remains outstanding.

With the development of industrially skilled workers and a growing regional market aided by a good transportation network, this area has concentrated on the production of high-valued metal products. The first national farm machinery center developed in Springfield to supply the Corn Belt farmers. As the farm implement manufacture declined, publishing and the manufacture of engines, pumps, trucks, automobiles, electrical machinery, and construction equipment began to employ Springfield people.

Dayton, which now has more than three-fourths of its workers in the metal goods industries, has a long history of transportation equipment manufacturing, starting with the buggy and wagon industries. Later, the airplane was invented and first manufactured here, and today the manufacturers of aircraft and automobile parts are important components of the industrial complex. Dayton has also gradually gained an international reputa-

tion as a producer of complicated machinery and electrical equipment such as cash registers and automatic calculating devices. Today, Dayton is the center of large plants and great specialization. These industries are characterized by high value added in the manufacturing processes, drawing their raw materials from many parts of the world. Many plants are attracted to the area because of the functional convenience, skilled labor force, and prestige found here. The high wages and generally pleasant working conditions have given such towns as Dayton a reputation as a desirable place to work.

Hamilton, located a few miles north of Cincinnati, was an early center for the manufacture of quality paper, wool and machinery. These industries were closely related. The endless woolen blanket invented in the area is used primarily by the paper industry. The blanket of felt is the best fiber upon which to dry wet cellulose being made into paper. This paper felt now has a national market. The Hamilton paper mills, by direct mail advertising, sell a large proportion of their paper for use in the manufacture of playing cards, shotgun shells, in wholesale trade, and in the printing and lithographing industries of Cincinnati and Dayton.

The metal industries prospered from the manufacture of paper making machinery because of the local market in Hamilton. About a century ago the manufacture of stoves began, and the output of heating equipment for gas, oil, coal and electricity continues. Another established activity is the manufacture of safes and vaults. The manufacture of coke and iron at Hamilton dates from the early 1900's. The manufacture of machine tools dates from the second decade of the present century.

Middletown, lying at the center of a rich agricultural belt, was early concerned with the processing of local agricultural raw materials. In this category are flour milling and brewing. About 1870 the making of tobacco products was introduced, and paper and machinery output were accelerated at about the same date. In 1901 a steel fabricating plant initiated the steel industry, and in 1926 the first continuous strip rolling mill was installed with a capacity of 40,000 tons of sheet steel per month. The availability of steel from Middletown greatly strengthened the metal fabrication industries of the Miami Valley.

Other centers. Columbus, Ohio and Indianapolis, Indiana are important manufacturing outliers in the region. Columbus, Ohio began as a commercial center and early manufacturing was limited to processing raw materials for local consumption. It was not until about 1870 that manufacturing became important in the city's industrial structure. The factories of the city expanded partly as a response to the increased importance of Columbus as a transportation center and the growing accessibility to timber, iron, coal, petroleum, and natural gas. The carriage and wagon shops gave the city a reputation as a leading carriage center. Other firms, emphasizing transportation equipment, produced railroad cars, iron rails, and equipment for the passenger and freight services of the railroads, which had shops in Columbus. A significant foundry industry developed in Columbus, although not on a level with that of Cincinnati and Cleveland.

Within the twentieth century three factors have been of prime importance in establishing Columbus as a manufacturing center. The first of these is the city's strategic central position, which gives it access to major market areas. Plants were attracted to the city by a second factor, a large, skilled labor force. A third factor has been the federal government. During World War II the government financed a major plant of the Curtiss-Wright Corporation. Local firms received contracts and subcontracts totaling millions of dollars. Many small factories were built in this period and have been able to continue operations to the present. In this way the government was an active force in creating industry and in affecting the expansion of both old and newly established firms.

A number of categories of manufacturing are found in Columbus. The transportation industries have continued to expand. A second group includes the production of equipment for the mining industry—continuous mining machines, steel castings for steam and electric shovels, mine cars, and cement mixers. A third group of metal manufacturers includes hardware, furnaces, machine tools, farm implements and metal furniture. Still another group

includes such diverse products as shoes, knit goods, clothing, plastics, papers, clay products, paint, beverages, and food products.

In Indiana, Indianapolis occupies the same type of strategic central position as that of Columbus in Ohio. Indianapolis developed early as an important crossroads for land transportation. Because of accessibility to the local and regional market, a wide diversity of manufacturing has arisen. Meat-packing and flour milling are traditional industries. However, manufacturing has concentrated on the production of machinery, automobile parts, knit goods, hardware, and metal fabricated products. The chemical industry is represented by pharmaceuticals and paint.

Outlying Nodes of Manufacturing

The boundary of the main manufacturing belt is moving westward. In part this reflects the growth of producers for tributary markets: bakers, printers, bottling works, and farm machinery. Possibly more important, this reflects production for distant markets. Meat-packing for example, is migrating westward from Chicago to those centers nearer raw materials. Improved refrigeration, salvaging of by-products, and transport facilities are making it more economical to locate slaughtering plants near the farms so that loss of animal weight in transit can be reduced to a minimum. Eastbound trainloads of refrigerator cars carrying meat account for heavy traffic on the Santa Fe, Chicago and Northwestern, and Illinois Central railroads from Kansas City, Omaha, and Iowa cities. Processed grain products likewise generate a heavy eastward traffic. A daily fast freight on the Chicago and Northwestern Railroad is "The Rapid," made up primarily of loadings from the Quaker Oats Company in Cedar Rapids, Iowa. Of these outlying industrial centers, St. Louis, Minneapolis-St. Paul, Omaha, and Kansas City are most important.

St. Louis. St. Louis, located at the crossroads of an east-west transcontinental and a north-south water route, has always been a major transportation center. Its strategic position made it an early trading center for western settlers. However, because of its outlying position and low market potential, manufacturing was slow in developing. Gradually in the early nineteenth century, with the settlement of the surrounding country, St. Louis became the center of a rapidly expanding economy.

By 1840 many industries were established which have provided the foundation for present-day manufacturing. Industry found favorable conditions for its growth here in the diverse raw materials of agricultural origin, mineral raw materials such as refractory clays, lead, and zinc, and coal from nearby Illinois fields, water and water power from the Mississippi River, a large supply of skilled artisans, especially from German immigrants, and, particularly, a large local and regional market. By 1880 the little settlement, founded nearly a century and a quarter before to promote the western fur trade, had become the leading commercial and industrial city west of the Mississippi.

St. Louis has become one of the most highly diversified of American manufacturing cities. More than 200 items—or approximately two-thirds of the classification of industrial products recognized by the Bureau of the Census—are produced in the St. Louis area. No single industry employs even as much as 10 per cent of the total labor force. The city is also distinctive in having about three-fourths of its factories within the city limits and immediate suburbs. The remaining quarter is found along the Mississippi River in Illinois.

Of the St. Louis industries the processing of local raw materials has been important. One of the earliest industries to prosper was that of tobacco, and between 1860 and 1880 the annual output of tobacco products exceeded that of any other American city. Principal items are chewing and smoking tobacco and snuff. Meat-packing originated in the middle of the last century and prior to the Civil War, St. Louis was one of the largest beef and pork packers in the nation. Although other cities have surpassed it, the slaughterhouses of this city still play a significant role in supplying the nation with meat. Largely as the result of availability of hides for leather, St. Louis has become a major shoe center. The brewing industry was one of the earliest, and malt liquors have flourished, particularly because of the demands of the local German population.

Nearby deposits of clay have contributed to the growth of major terra cotta and brick industries. Lead from southeast and southwest Missouri has made St. Louis the foremost producer of white lead.

Metal and metal product industries have experienced considerable expansion in recent years. A primary iron and steel industry has developed based on iron ores from the upper Great Lakes and coal from Illinois and Oklahoma fields. In East St. Louis is located the oldest and largest bauxite processing plant for producing alumina in the United States. A highly diversified group of metal fabricated products is produced. The manufacture of stoves and ranges, which has always remained prominent, is an industry dating from 1842. Other metal products include farm equipment, rolling stock, machine tools, and, in recent years, electrical equipment, which has expanded rapidly.

St. Louis has developed still other types of manufacturing. In apparel, the manufacture of women's and men's clothing is important. The output of chemicals and allied products includes general chemicals, paints and varnishes, and pharmaceuticals.

Minneapolis-St. Paul. The Twin Cities, originally separated by about ten miles, have gradually merged physically, although they have remained distinct political units. Early settlers founded St. Paul at the head of navigation on the Mississippi, while Minneapolis grew on the west bank of the river from the St. Anthony Falls, the best natural power source on the Mississippi. These cities are the economic focus for three major regions: the Spring Wheat Country to the west, the Dairy Region to the north and east, and the northern margin of the Commercial Crops and Livestock Region. The site of these cities and their regional position have greatly influenced their industrial development.

The raw materials of these regions most easily assembled at Minneapolis-St. Paul have been of major significance in establishing the original industries. From 1840 until the early 1900's the lumber industry dominated manufacturing, for three reasons: proximity to the white pine forests of the north, feasibility of floating logs down the Mississippi River and its tributaries, and available water power from the Falls of St. Anthony. Minneapolis was the lumber source for the vast plains lying to the south and west for more than two-thirds of a century.

Gradually the timber resources were depleted; but with the decline of the lumber industry, the processing of wheat expanded. The industrial importance and prosperity of Minneapolis today are directly related to this industry. The great mills bordering the banks of the river below the falls are the most striking features of the urban landscape. Serviced by ten railroads, Minneapolis has been for a long time the principal collecting point for spring wheat from Minnesota and the Dakotas. Although flour milling has declined relatively with the growth of the Great Lakes grain trade, the rise of Buffalo, and the expansion of milling at Kansas City in the Winter Wheat Belt, Minneapolis has maintained her position as the nation's third milling city.

The processing of other agricultural products continues to flourish. Minneapolis is the nation's principal market for flax and is noted for its output of linseed oil and oil cake. With the region's expanding dairy industry it has become a major center for butter production. St. Paul is noted for its slaughterhouses and is the third or fourth largest market for beef cattle in the United States. A brewing industry is found in both of the Twin Cities.

The requirements of the Twin Cities' agricultural hinterland for manufactured goods have fostered certain types of industries. Such manufacturing includes farm machinery, fertilizer, bags and twine, construction equipment, electrical machinery, and work clothes.

Kansas City. Kansas City, situated on the Missouri River, had its origin as an outfitting point for settlers moving to Santa Fe and other points in the West and Southwest. Its strategic location made it an early transportation focus. With the development of the railroad, it became a center for the collecting of the region's agricultural commodities. At an early date it developed as a major slaughtering and meatpacking center. This was made possible by the development of cold-storage and refrigeration plants, which facilitated the shipping of dressed meat—rather than live animals—to the large eastern market. Proximity to the Hard Winter Wheat Belt also enabled Kansas City

to become a wheat market and attain first rank in flour milling.

Because of Kansas City's strategic position in relation to the interior market a large number of types of manufacturing developed here. Kansas City was one of the first cities to obtain a branch automobile assembly plant. The first of these was built by the Ford Motor Company in 1910. At the present time General Motors also assembles automobiles in the metropolitan area. Shortly after World War I a primary iron and steel industry developed in the city. This encouraged the growth of the machinery and metal fabricating industries.

The impetus to industrial growth given by World War II has been significant in shaping the present-day character of industry in Kansas City. During the war period the United States government built large factories to produce airplanes, ordnance, and chemicals. Although ordnance manufacture has declined, the other World War II industries have prospered. This is partly due to the decision of the West Coast airplane producers to maintain a significant portion of their industry in the Midwest. The immediate availability of petroleum and natural gas has fostered the continued growth of the chemical industry.

In the post-World War II period Kansas City exhibited the greatest industrial growth of the midwestern cities. Between 1947 and 1954 the value added by manufacturing in the Kansas City metropolitan area doubled. However, between 1954 and 1960 there was little increase in the value-added figure. At present Kansas City has a value added in manufacturing of just over $1,000,000,000, of which nearly 20 per cent is food and another 20 per cent transportation equipment. Chemicals comprise more than 10 per cent of the manufactured products.

Omaha. Omaha developed as a railroad center, with its major function being the collecting of cattle from the area to the west. The first stockyards were built in 1884; they functioned for a long period as merely a feeding station for range animals. Gradually, Omaha's strategic position on the eastern edge of the Great Plains for the development of a meat-packing center was recognized. At an early date a flour milling industry was also established in the city.

As a rail and highway converging point Omaha has become Nebraska's leading metropolis and possesses about 60 per cent of the state's manufacturing. As the center of a vast and productive agricultural area, Omaha's manufacturing continues to be dominated by the processing of food. In 1955 the city became the world's largest livestock market, surpassing Chicago as a packing center. Omaha is also the world's largest butter producer and a large producer of frozen food products. Other foods include breakfast foods and spaghetti.

Industry in Omaha began to diversify in World War II. The city became a major producer of aircraft and this industry has continued to produce planes. However, it was soon recognized that an aircraft industry largely dependent on defense contracts would not bring industrial stability to the city. In order to diversify the industrial structure of the area the Omaha Industrial Foundation was created in 1952. This foundation acquired a 453-acre tract in the rolling hills southwest of the city which was graded, installed with industry-size water and power lines, and given heavy-duty paved streets together with railroad spurs. This was the first of a number of specified industrial tracts. As a result of this type of inducement, a considerable number of industries have built new plants in Omaha.

Of these new activities, the chemical industry is of considerable importance. One of the largest plants produces fertilizers. The selection of Omaha as the site of a new plant, according to officials of the Allied Chemical and Dye Corporation, depended on three major and a number of minor factors. The first was the expanding market for fertilizer to be found in the prospective growth of wheat, corn, and cattle production in the Omaha area. Second was the availability of natural gas, which supplies the hydrogen that goes into the nitrogen compounds. The third was the adequate supply of water, both above and below ground. It was also recognized that Omaha is large enough to have a branch or agency of almost every important manufacturer of supplies and equipment a nitrogen plant requires.

The machinery and metal fabrication industries have also migrated to the city. The need for farm implements has encouraged the

expansion of this type of industry. A number of electrical machinery plants are also firmly established in the area.

Omaha in 1960 had over 33,000 industrial workers, producing goods with a value-added figure of over $300,000,000. Between 1947 and 1960 the value of Omaha's manufactured products increased nearly 90 per cent. It is anticipated from present trends that diversified manufacturing will become more important in Omaha's total economy.

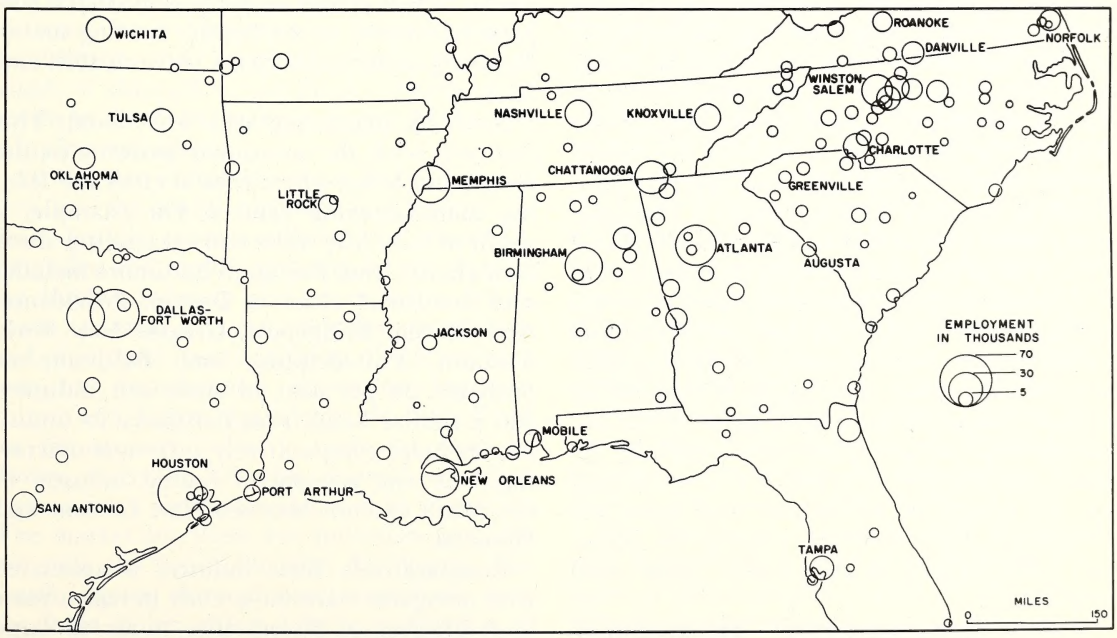
The South

The vigorous economic resurgence of America's Southland is associated with a notable increase in manufacturing. From Virginia to Texas, new factories are springing up not only in cities and smaller communities, but also in rural areas. This expansion of manufacturing in the South's economy, which for decades had been primarily agricultural, has mushroomed in the past forty years and constitutes a conspicuous aspect of growth in America's economic history.

What is the South? There appears to be no sharp line which can be said to delimit southern manufacturing regions from those to the north (Map 2.16). East of the Mississippi River a less industrialized zone extends through southern Kentucky, southern West Virginia, and northern Virginia. If this be taken as the dividing zone, then the South, in terms of a pattern of manufacturing, can be said to consist of Virginia, North Carolina, Tennessee, Arkansas, Oklahoma, and states south of these. Admittedly, many states (such as Kentucky, Maryland, and Delaware), considered by tradition and other criteria to be "southern," are not included. Kentucky, West Virginia, Maryland and Delaware are more closely related to the northern manufacturing belt than to the southern.

How much manufacturing does the South have? Factories within the region delimited have approximately three million employees on their payrolls. This is 18 per cent of the nation's total and is roughly equal to the combined factory employment in New York, New Jersey, and Maryland. In terms of value added in the manufacturing process southern factories account for 19 per cent of the nation's total.

Southern manufacturing has increased



2.16. United States—Location of Manufacturing in the South.

TABLE 2.13

Number of Employees in Manufacturing

Year	*The South*	*The United States*	*% of U. S.*
1899	572,078	4,850,119	11.7
1909	935,730	7,012,066	13.3
1919	1,209,277	9,836,801	12.2
1929	1,402,983	9,659,742	14.5
1939	1,483,155	9,527,306	15.5
1947	2,171,980	14,293,963	15.1
1954	2,595,526	15,651,294	16.5
1958	2,988,000	16,046,945	18.7

Source: United States Census of Manufactures, U.S. Department of Commerce, Washington, D.C.

rapidly in recent years, more rapidly than in the United States as a whole. The number of manufactural employees in the South has been multiplied about fivefold since 1899, while the United States total has been a little more than trebled.

The most phenomenal period of growth followed World War II. Between 1947 and 1958 southern factories increased their number of jobs by over 35 per cent, nearly three times the national increase. The South is riding the crest of an industrial boom which began stirring noticeably just before World War I, slowly gathered momentum, catapulted during World War II, and continues at an accelerating speed (74).

Even so, the South is still an agricultural region and has a long way to go before rivalling the industrial North. For example, while manufacturing's share of total employment in the United States is about 30 per cent, in the North it is 33 per cent, and in the South 20 per cent. Though growing spectacularly, southern industry still comprises a comparatively small proportion of southern livelihood as well as of the nation's total manufacturing.

A conspicuous portion of southern growth is through new companies and new factories rather than through expansion of former facilities. Consequently, the South is typified by modern industrial structures, many of the all-on-one-floor design. Since such buildings require considerable area they are often located on the fringes of settlements and many are situated in rural territory, tapping the potential labor supply of the South's large rural population.

Pattern of manufacturing. The geographical pattern of manufacturing in the South is portrayed by Map 2.16. Manufacturing is confined to relatively few parts of the South. The pattern is one of industrial centers rather than industrial belts, one exception being the rather continuous band of industrial counties and cities extending from Virginia to Alabama. Throughout the rest of the South the lack of contiguity produces a dispersed pattern of industrialization.

There are no large industrial centers comparable to those of the North and Far West. The South has no single manufacturing center as large as Los Angeles, San Francisco, or Seattle. The South's leading center of manufacturing, the Dallas industrial area, with 96,000 employees, ranks as only the twenty-fourth largest center in the nation. Dallas surpassed Houston as the South's leading manufacturing center in the years between 1954 and 1958.

Most manufacturing areas are inland. This contrasts with the locational patterns in the North and West, where coastal cities are leading manufacturing centers. For example, a swath of land fifty miles wide extending along the Atlantic from Boston to Baltimore includes such industrial cities as Boston, Providence, New Haven, Bridgeport, Greater New York, Trenton, Philadelphia, and Baltimore—or probably 20 per cent of American industry. But a similar band from Baltimore to Louisiana includes comparatively little manufacturing. The one segment of coastal industry in the South extends between New Orleans and Houston.

Comparatively little industry is associated with navigable waterways. Only in recent years have Mississippi River cities attracted large industrial establishments.

Industrial structure. For the South as a whole, industries supporting the largest number of job-holders are textiles, lumber, foods, apparel, and chemicals. Some of these are found throughout the South and thereby contribute toward regional homogeneity. Others are concentrated in restricted portions of the South.

Unifying industries. There are five industries whose widespread distribution tends to unify the South: lumber, foods, apparel, chemicals, and paper.

The manufacture of lumber products extends from Virginia to Texas and is performed mostly in sawmills and planing mills. Structural timber and crating material are leading items, with much of the product shipped to northern markets. This activity is typical of small settlements and is carried on in a host of establishments, few of which are very large. Most food factories in the South are small in size and produce for local markets. Exceptions are slaughterhouses and canneries. The apparel industry fabricates cotton and synthetic garments and appears in nearly every southern state. Chemical industries resemble the lumber industry by reaching outside the South for a major share of sales. Fertilizers and industrial organic chemicals made of southern raw materials are typical of this group. Paper mills, scattered from Virginia to Texas, produce paperboard and wrapping paper, most of which is shipped to northern consumers or northern factories making paper boxes and shipping containers.

Of the five industries whose locational pattern ties the South together as a region, all draw heavily upon southern raw materials. Extensive and rapidly growing forests support the lumber industry and paper mills. Water power, natural gas, salt, sulphur, petroleum, and phosphate constitute most of the resource base for the chemical industries. Southern cotton and forests again provide ingredients for the apparel industry. Only the food industry, especially bakeries, depends on other regions for a significant share of its materials. The market for these five industries includes not only the South but also the North. The South is going through a metamorphosis from the stage of importing a large proportion of her manufactures from the North to the stage of making some of these items herself and actually producing a surplus for export to other parts of the country.

Concentrated industries. Five important industries are restricted in location to specific parts of the South. Textiles, furniture, and primary metals are for the most part east of the Mississippi River. Petroleum and transportation industries are concentrated in the four western states, with a pronounced gathering along the Gulf Coast. These five industries process southern raw materials, but much of their sales are in the North.

Industrial regions and centers. The South can be divided into two major industrial regions. The Southeast is primarily a textile-lumber-apparel region, with foods, chemicals, primary metals, furniture, paper, and tobacco also being important. Industrial employment exceeds 1,890,000 people—about the same number as the state of New York. By contrast, the Southwest is distinguished by its lumber and petrochemical industries, although the processing of foods employs the largest number of people. The four states in this region—Texas, Louisiana, Arkansas, and Oklahoma—have an aggregate of about 800,000 employees in manufacturing, about the same number as the state of New Jersey.

The Southeast Belt. The heart of the industrial Southeast is a wide belt of manufacturing extending from Virginia to Alabama. Its pattern resembles an elongated loop encircling the Blue Ridge Mountains, which appear as a blank area. This loop is continuous and much wider in its eastern portion, where the band of industrialization attains a width of 100 miles, especially in North Carolina. The western portion of the loop is narrower and less continuous and is associated with a string of settlements in the Great Valley of Tennessee. Overall, the Southeast Belt extends approximately 500 miles from northeast to southwest and 150 miles across. Leading centers of factory production are Birmingham, Atlanta, Chattanooga, Winston-Salem, High Point, Greensboro, and Knoxville.

The Southeast Industrial Belt is inland, with a pronounced concentration in the Piedmont, a physiographic region of low rolling hills situated between the rough terrain of the Blue Ridge to the northwest and the flat, less

well-drained coastal plain to the southeast. This is frequently referred to as the Piedmont Manufacturing Belt. This industrial band is associated with a high density of population which in turn is associated with more productive farm lands than are found on the coastal plains or the more hilly interior. The gradients of numerous streams provided a water-power potential developed by many Piedmont localities. Coastal portions of Georgia, the Carolinas, and Virginia so far have had less population, poorer agriculture, and no water-power sites.

Textiles are the leading industry in the Southeast. They represent more than one-third of the manufactural activity and comprise about one-half the American textile industry (55). Many textile mills have been constructed by northern companies which initially operated them as branch factories to supplement production in their northern plants. But for many reasons, such as lower labor costs, lower taxes, lower power costs, and more efficient mechanization, southern mills began showing a greater margin of profit. The northern parent companies began channelling new investment capital into southern locations and ultimately ceased or sharply curtailed operations in northern plants. The rapid development in southern textiles has been partly the result of natural expansion of the nation's textile industry and partly of an actual transfer of northern operations. Originally, southern mills concentrated on coarser textile goods; but recent years have seen an upgrading in quality of products. The market is nearly nationwide. Raw materials are produced in the South but this factor has been overrated in explaining the vigor of the South's textile industry. Most of this industry is in the Southeast, but the greater part of the cotton is produced in Texas and the Mississippi Valley.

Textile mills characteristically are modern. Many are two, three, or four stories in height, but an increasing proportion are expansive all-on-one-floor structures. In many instances a new mill has been constructed in rural areas adjacent to a dense rural population, initially depending on rural, commuting labor which soon settled near the mill, causing the development of company towns. Such settlements depend for their entire livelihood upon the mill, which frequently supports additional commuting labor. Such a town is Piedmont, South Carolina, a community of 2,500 people whose economic life revolves around the Piedmont Manufacturing Company. This operation employs 1,000 people in the production of muslin; 800 of these people reside in Piedmont, 100 live on farms, and 100 commute ten miles from Greenville. The textile plant is the only industry in the community. All the grocery stores, clothing stores, gas stations, and other services depend for their existence upon the mill's payrolls. This is a company town in more ways than one, for as late as 1950 the company owned all the homes as well as many of the retail businesses; home rentals averaged 50 cents per room per week. In that year the company sold the homes to the employees at modest prices. The company maintains a community center, a ball park, and educational facilities in the town, as well as a resort in the mountains where each employee's family receives one week of free vacation per year.

Textile factories attain a degree of dominance in some communities scarcely equalled in any other manufacturing area. Gaston County, North Carolina, for example has 28,000 people employed in all of its factories—27,500 of them are in textile mills! In Cabarrus County, North Carolina 17,000 out of 22,000 employees are in textiles; in Greenville County, South Carolina, the ratio is 23,000 to 29,000. In Spartanburg County, South Carolina, it is 19,000 to 25,000. Oftentimes one has to measure the location of the textile industry by counties instead of cities because many of the new mills are in rural areas. This is true not just for textiles but for much of southeastern manufacturing in general. For example, of Greenville County's 29,000 industrial employees, only 5,000 work in city factories; in Gaston County the ratio is 28,000:6,000; Spartanburg County 25,000:5,000; and Cabarrus County 22,000:6,000.

The tobacco industry, like textiles, is highly concentrated in the Southeast Belt. Most of America's cigarettes are produced in the Piedmont portion of the Carolinas, particularly in Winston-Salem, and Richmond, Virginia. However, there is little evidence of tobacco factories dominating the economic life of communities as do textile mills. For example, less than one-half of Winston-Salem's manufac-

tural job-holders depend upon tobacco factories for their pay checks. Richmond, second only to Winston-Salem in the tobacco industry, has 41,800 industrial jobs, of which 17,000 are in tobacco factories.

The Southeast Belt has considerable lumber industry and food processing which, although employing many more people than the tobacco industry, are not as distinctive of the region. Furniture is a significant industry in the Southeast Belt but it is not a large employer of industrial personnel and dominates the industrial activity in no major area. High Point-Greensboro, North Carolina, is the leading furniture center but only 6,470 of its 42,200 manufactural personnel are in furniture production.

One portion of the Southeast Belt is distinguished by an anomalous type of industrial activity. The Birmingham, Alabama area is not a textile, lumber, or tobacco center. It is a metal goods producer, with primary metals, mostly iron and steel, accounting for half the area's industry. It is unique, not only as the South's only basic iron and steel center but also as the nation's only producer having local supplies of three raw materials: coal, iron ore, and limestone. Its primary metal industry has attracted machinery producers and other fabricators of metal products. Birmingham also is noteworthy because of the total amount of industry here: with 63,600 industrial employees it ranks only behind Dallas and Houston as the leading industrial area of the South.

In short, the Southeast Manufacturing Belt from Virginia to Alabama has numerous factories providing the largest number of jobs in textiles, lumber, and food production; but the industries which distinguish it from other regions are textiles, tobacco, and furniture.

Elsewhere in the Southeast there are a number of detached centers of manufacturing: Memphis, Nashville, Richmond, and Norfolk. A few port cities have enough industry to appear on the map, but they are considerably detached from the Southeast Industrial Belt, and are not leading foci of manufacturing. Some areas of the Southeast are conspicuously nonindustrialized: the southeastern, flat, less well-drained portion of Georgia, most of Florida, the Carolina coastal plain, and the hill country of Kentucky and Tennessee.

The Southwest. There are several contrasts between manufacturing in the Southeast and in the Southwest. First, the pattern of manufacturing is different; there is no manufacturing belt, but rather several segregated nodes. There is considerable manufacturing along the coast; in fact, three major centers of manufacturing—New Orleans, Beaumont-Port Arthur, and Houston—are accessible to ocean-going vessels. There is less manufacturing in the Southwest than in the Southeast, the ratio of industrial employment being about 1:3. The recent rates of growth are also different, but in favor of the Southwest, where manufacturing is increasing at about twice the rate of the Southeast. Furthermore, the leading industries differ; in the Southwest they are lumber, foods, petroleum, and chemicals, while in the Southeast they are textiles, lumber, foods, and apparel. The raw material and power bases are different: petroleum in the Southwest, coal and water power in the Southeast.

The Southwest has only three areas where industry at present is concentrated: a hundred-mile strip along the Gulf Coast, which is highlighted by Houston and Beaumont, where industrial employment approximates 130,000 workers—although the rapidity of expansion here makes the accuracy of any estimate questionable; the Dallas-Fort Worth area where 150,000 or more people are on factory payrolls; and New Orleans, which has over 45,000 manufactural employees. Each of these three nodes has its own distinctive industrial characteristics.

The Gulf Coast. The Gulf Coast specializes in petroleum processing and chemical production, using nearby raw materials of crude oil from both inland and tideland wells, natural gas, sulphur, salt and magnesium salts from sea water, and calcium carbonate from oyster shells. Not only is petroleum processing, including petrochemicals, the leading industry here, but this is also the nation's leading concentration of petroleum refining. Beaumont, plus its port of Port Arthur, ranks first in the United States in capacity of oil refineries. Located on the Gulf Coast Oil Field this territory also is advantageously situated for transport facilities, since ocean tankers can dock alongside the refineries. It is generally

accepted that the ocean tanker is the least costly form of transporting petroleum.

Cost per ton-mile of transporting petroleum

Truck	$0.0612
Railroad	.0169
Pipeline (crude)	.0034
Water	.0008

Source: U. S. Department of Commerce, Office of Domestic Commerce, Industry Report, Domestic Transportation, Petroleum Transportation, 1959.

The oil boom along the Gulf Coast is of recent vintage, the first oil strike having been made in 1901 a few miles north of Beaumont on a hill called Spindletop. At that time Beaumont was a community of 9,000, depending for its livelihood upon sawing logs, milling rice, and shipping cattle, the three main items produced in its hinterland. With the discovery of oil, Beaumont changed from a small city to a bustling agglomeration of 70,000 people, focal point of the oil boom. Petroleum processing became the leading industry, accounting for nearly 75 per cent of all industrial employment in Jefferson County (Beaumont and Port Arthur) and began attracting other kinds of manufacturing.

Although Jefferson County has the most oil refining, Harris County, containing Houston and numerous factories along the Houston Ship Channel, has more manufacturing. Houston has access to the sea, is atop the Gulf Coast Oil Field, is better situated for access to the interior, and is a regional center with an extensive sphere of commercial influence. Consequently, Houston's industry is more diversified, with approximately the same number of people employed in fabricating oil field machinery and in processing petroleum.

In addition to the urban areas a dramatic industrialization has taken root in rural areas, along the Houston Ship Channel, the coast, and railroads. These factories, mostly sprawling chemical plants, have attracted urban settlements around them. The spectacular Dow Chemical plant near Galveston is one of the best known examples of the chemical industry in the area.

The Dallas-Fort Worth area. The Dallas-Fort Worth area is different from the Gulf Coast, though growing with much the same Texan enthusiasm as prevails in Houston and Beaumont (58). Fort Worth and Dallas are 250 miles from the coast, 50 miles from oil fields, and have a different industrial structure. There are no significant raw materials produced in their immediate hinterlands except the products of agriculture. Aircraft production is the leading industry and depends on other parts of the country for both raw materials and markets. Much of it is here as the result of government encouragement in World War II, since inland portions of the Southwest were removed from congested factory concentrations, comparatively less vulnerable to possible enemy attack yet proximal to a satisfactory labor supply. The second industry is foods, which partially depends on a Texas market for sales and Texas ranches for cattle, this being the leading meat-packing center of the Southwest.

Dallas has more manufacturing than Fort Worth, a much more diversified group of industries, and is more the regional center, manufacturing many of the goods consumed in the interior Southwest (59). Next in importance to transportation equipment, the two leading industries in Dallas are apparel and foods, each representing less than 15 per cent of total industry, followed by printing, machinery, electrical machinery, and fabricated metals. Such an industrial structure typifies a focal community serving a major region. Fort Worth by contrast has about 40 per cent of its manufacturing in aircraft and 15 per cent in foods, mostly meat-packing.

New Orleans. New Orleans is distinguished among southern industrial centers by its shipbuilding and food industries, the former serving a national and the latter a regional demand, although New Orleans canneries export sea foods to numerous northern customers.

Other centers. There are numerous small communities and rural areas with factory enterprises. The lumber and paper industries are predominant in many of these places. The number of such settlements is so large that their aggregate lumber employment exceeds that in more spectacular industries such as petroleum refining, chemicals, and aircraft. The lumber and the paper producers depend entirely upon local raw materials, growing at an accelerating rate based on the extensive southern forests. These forests, once rather seriously cut over, are recovering rapidly.

In the Southeast and Southwest there are many other types of industries other than those discussed which serve not only local demands but in some instances export to other parts of the nation. In this less conspicuous group are printing and publishing, leather processing, production of stone, clay, and glass items, and auto assembling.

Relationships between manufacturing and other factors. The upsurge of southern industry is associated with several factors, some of which have influenced its growth, some of which have been the result of its growth, and some of which have involved relationships of both cause and effect. The following factors are important.

Natural resources. The South is well-endowed with such industrial resources as forests, petroleum, water power, and sulphur. There is some coal, particularly in the southern extension of America's greatest coal region, the Appalachian, which extends from Pennsylvania to Alabama. In many parts of the world, manufacturing areas have taken root on coal fields. This, however, has not been the case in the American South, with the exception of the Birmingham area. It isn't that coal cannot be mined easily; West Virginia and eastern Kentucky comprise the country's leading coal exporting region. Part of the answer is the hilly terrain; yet railroads penetrate the region to serve the coal mines—they could just as easily serve factories. The fact is that the hilly topography does not provide expansive sites of flat land for large factories, although the population is large enough to provide factory labor forces. The South's major coal field is an unusual area, one with a comparatively large rural population and a rich endowment of coal, but with an economy which to date has exported its coal rather than basing local industry on it. Understandably the area has few large cities—without manufacturing, cities rarely become very large. The probable explanation of this anomaly lies in the low standard of living, which relates to the low standard of agriculture. "Poor soils make poor people," and poor people do not generate strong buying power or a market to attract industry. Unable to develop industry with its weak buying power, the other alternative was that outside capital might be invested to tap the labor supply. But outsiders apparently have not considered the human resources of the area a good labor investment. Consequently, the area's coal has been shipped to factories elsewhere.

Natural resources are important, but they have existed for centuries. It was not until human initiative was reborn, especially in the Southeast, that poor soils began to produce more crops, that a degenerating one-crop agricultural system was transformed into a lucrative, diversified system, and that a cut-over and deteriorating forest was transformed into a healthier sustained-yield component of the South's economy.

Human resources. A new birth of confidence, enthusiasm, and initiative has seen southerners beginning to handle their natural resources more wisely. They have improved their soil conservation and cropping practices, with the result that farm income has risen sharply. They have adopted forest conservation and tree harvesting practices, creating greater income from this resource. With wiser use of older resources and development of new ones, the South has generated a rapidly expanding purchasing power, a strengthening market which has attracted considerable industry simply to serve the increased local demand.

But the human resource has encouraged other industries—those serving markets far beyond the local constituency. In many instances these are processors of southern raw materials —trees, cotton, petroleum, and others; thus, there is a steady flow not only to southern users but also to northern buyers of petroleum, lumber, crating material, wrapping and building papers, textiles, furniture, and cigarettes.

Yet many factories have been successfully established neither primarily to serve the southern market nor to process southern raw materials, but rather because southern labor looked to be a promising resource. The aircraft, shipbuilding, and much of the textile industry are in this category. Through the years this factor has been measurably effective in terms of labor costs. In many industries labor costs per unit of goods have been less in the South than in the North because of output—the ability of southern people to produce. A New England textile company, Textron Incorporated, operating branch plants in

the South estimated that their branch plants were producing wide muslin sheeting at the rate of 9.62 pounds per man hour while the home plant's rate in New England was 5.37. The same company estimated that its tax load in New England was $2.53 per spindle, while in its South Carolina plant it was 58 cents. Power costs vary, according to Textron's conclusions, from 1.2 cents per kilowatt-hour in New England to 0.8 cents in the South.

Other factors have also been operating to attract new industrial establishments. Some southern states and communities have offered attractions in the form of direct or hidden subsidies, such as providing a building and granting special tax reductions. However, in the overall picture of factors luring industry to the South, these benefits are probably of minor importance. The development of an adequate transportation system has also encouraged industrial growth. Southern highways have been sufficient to support truck transportation, and the railroads, especially the Southern Railroad, have outdistanced all others in the nation in efforts to attract factories.

Government allocation of war contracts and certificates of necessity played a part in building some southern industry. Spectacular examples of federal activity are the T.V.A. project, providing hydroelectric power, and atomic energy plants, such as at Aiken, South Carolina and Augusta, Georgia.

Consequences of the South's industrial revolution. The renaissance in southern agriculture and forestry, the development of water power, and the discovery of oil—all of these so stimulated the wealth of the South that it became an attractive area for the growth of industry. This growth has resulted in a number of significant changes. Because of increased jobs, which brought new wealth to the area, the standard of living has been raised considerably. There has also been a rapid growth of cities. Between 1950 and 1960 the urban population increased about 35 per cent, faster than in any other region in the nation. Practically all of the leading American cities with the most rapid rates of growth between 1950 and 1960 have been in the South and the Far West. In both areas the urbanization boom is strongly predicated on industrialization.

The growth of industry has been influential in slowing the population exodus, especially the flow to the North. As more and more job opportunities develop in the South, the number of people migrating outward diminishes; the outflow of the human resource which has been going on for decades is definitely being retarded. There has also been a change in the composition of the population. A decrease in the proportion of Negroes is notable. In 1860, 35 per cent of the South's population were Negroes; in 1960 the proportion was about 20 per cent. Proportionately more whites are remaining, and even migrating to the South. The industrial evolution of the South is changing not only the regional economy, but also the area's social structure.

Interior West

In the Interior West there are no great manufacturing regions similar to those on the West Coast or in the East. This area presents a fragmented pattern of manufacturing centers. The region's industrial structure is characterized by the processing of local raw materials. Thus, food processing, such as meatpacking, flour milling and sugar refining, lumber industries, and the smelting and refining of metals are traditional industries in the industrial economy. In recent years manufacturing has become more diversified with the growth of such industries as transportation equipment, machinery, and electronics.

Size of industry. The ten states of the Interior West have, collectively, over 250,000 people employed in manufacturing.[5] This is about equal to that of the Cleveland metropolitan area and essentially the same as that of the state of Virginia. Most of the manufacturing is concentrated in Colorado, Arizona, and Utah, which have about 155,000 industrial employees. The significant feature of industrialization in this region is its very rapid rate of growth since 1939. During the period between 1939 and 1958 total industrial employment increased approximately two and a half times, and value added in manufacturing rose from $293,263,000 to $2,529,185,000, an in-

[5] These states include Arizona, New Mexico, Colorado, Utah, Wyoming, Nevada, Montana, Idaho, interior Oregon, and interior Washington.

crease of more than eight times. The rise in value added reflects the emphasis placed on products of low bulk and high value in order to withstand transportation charges to a distant market.

Factors of localization. A number of factors have been significant in retarding industrial development. One of the most important handicaps has been the very small population. For example, Colorado and Utah, two of the most important manufactural states, have a population less than that of Connecticut. The great distances to sizable markets outside the area have likewise limited industrial growth. In addition, it has been claimed that until 1949 the established freight rate structure and the basing point system limited manufacturing growth. Finally, it is generally believed that the conservative economic philosophy of western businessmen has been an inhibiting influence to industrial growth (44).

Although these adverse conditions have not disappeared, they are no longer as important as they once were. Population is still small, but the rate of growth for most of these states greatly exceeds the national average. A market is growing for locally produced consumer goods. The advantages of producing products consumed locally are many. One of the most significant of these is the reduction of freight rates. There is also the consideration of facilitating customer service for many manufactured products. In recent years new firms producing food and kindred products, glass, furniture, electrical products, chemicals, building materials, machinery, and others have entered the region because of the expanding market.

The availability of raw materials is playing an increasing role in the establishment of industry in this area. The mineral resources are of particular importance. These include coal, iron ore, copper, petroleum, salt, gypsum, and clays. As a result of the availability of such semifinished products as steel and copper, industries have established plants in the area to utilize these materials.

New industry has rarely been attracted to the area by the size of the labor body. Nevertheless, other labor considerations have been influential in attracting certain types of manufacturing. The per capita wage payments in many industries are considerably below the national average pay scale. There is also less unionization of industrial workers in this region than in the more concentrated industrial regions. Lower labor costs and limited union activity have been the motivating factors in the establishment of certain industries.

Within the area governmental influences, particularly the federal government, have been significant in attracting new industry. The isolation of the area from enemy attack plus the demands for war materials on the Pacific Coast during World War II and the Korean War resulted in heavy government expenditures for manufacturing. The outstanding example of government influence was the building of the Geneva integrated iron and steel plant, which began operation at Provo, Utah in 1944. It is unlikely that a private company would have invested the $240 million needed to build this plant. Many other plants have been established since World War II in abandoned air and army base facilities. In addition government spending has provided a considerable market for products produced. State and local governments have also attempted to induce industry to enter the region.

The influence of certain aspects of the physical environment, particularly climate, appears to play a more important role in the Interior West than in many other areas of the United States. Climate, although it does not play a direct role in the efficiency of industrial production, is important in that factory owners apparently want to live in the type of climate found in this region. This is particularly true in Arizona. The region is thought to be a desirable place to live, not only for the climate, but because of its attractive cities and nearby recreation areas. The firms that develop because of these amenities are of the type that could be located almost anywhere in the United States. That is, they normally produce a high value-added product which can withstand high transportation rates in its marketing.

Location of manufacturing. Throughout the vast areas of the Interior West, manufacturing is important in a number of isolated centers. In this region only four districts are of significance. In the state of Colorado an industrial zone has developed on the eastern flank of the Rocky Mountains, extending from

Denver to Pueblo. In interior Washington an industrial district centers on Spokane. Within Utah the major industrial concentration is localized in the Ogden-Salt Lake City-Provo area. Finally, Phoenix, Arizona is a rapidly expanding industrial node.

Denver-Pueblo area. The Denver-Pueblo area is the leading industrial district of the Great Plains. Denver, the gateway to the Rocky Mountains, began as a mining center and developed as an important commercial city through the economic growth of the region.

The traditional industries of this section are those which process local raw materials and those which have a local and regional market. The food processing industries developed early and remain important. At present, more than 40 firms, each employing 100 or more workers, are located in the Denver-Pueblo area. The food processing firms possess about one-third of the total manufacturing employment, and a little more than one-quarter of the value added. Food processing includes canning of vegetables and fruit, sugar refining, meat-packing, and flour milling.

The processing of ores is another traditional industry in this region. At present primary metal manufacturing is dominated by the Colorado Fuel and Iron Corporation plant in Pueblo. This plant employs over 10,000 workers and is the largest in the state. This industry developed in the nineteenth century and was for a long time the only integrated steel plant west of the Mississippi. It was a major supplier of rails to the spreading railroad network and of wire to the farmers when the open range was being fenced. The plant is fuel oriented, having its own coking coal nearby. The iron ore must be imported from Utah and Wyoming. Unlike a number of the recently established steel plants in the West which have not had time to diversify their products, the Colorado Fuel and Iron Corporation produces a wide variety of steels. Other leading primary metals plants are the Leadville and Denver operations of the American Smelting and Refining Company, processing nonferrous ores, and four gray iron foundries in Denver. There are a number of fabricated metal firms in Boulder and Denver making structural steel, boilers, and sheet metal products.

The machinery industry began in Denver with the demand for locally produced mining and construction equipment. These industries are represented today by Gardner-Denver, Timken Roller Bearing, and Stern-Roger, the latter being internationally known in the design and construction of whole industrial plants. The transportation industry is represented by firms producing aircraft and automotive parts and accessories. The Denver area has also become an important producer of scientific and industrial instruments.

The newest industries of the region are associated with missile technology and electronics. The low proportion of total cost formed by raw material and high value of the finished product freed companies from many traditional considerations in locating new plants here. The largest of the new firms is the Martin Company, which builds the Titan missile in Denver. The plant opened in 1956 and has expanded rapidly, so that employment has reached about 10,000 workers. A number of allied industries have developed plants in the Denver-Pueblo area.

Certain other industries exist in this region. The two largest chemical concerns are Shell Chemical in Denver and the Du Pont powder plant in Louviers, southwest of Denver. Two conventional petroleum refineries are located in the region. The rubber and plastics industries have developed rapidly and are now important, and the leather goods industry is represented by the Samsonite luggage company. Locally available hides formed the basis of the original activity, but today, with little leather being used in luggage, the fine reputation of the product has become its chief asset.

Phoenix. The growth of Phoenix as a major industrial node in the Interior West has been of recent origin. As late as 1939 this area had fewer than 2,000 industrial workers. However, by 1955 the industrial workers had increased to nearly 26,000. During the same period the value added in manufacturing rose from $8,350,000 to $220,552,000. Approximately two-thirds of those engaged in manufacturing in Arizona are located in Phoenix.

Within Arizona, Phoenix occupies a strategic location. It is centered in the largest area of flat land within the state, and water from the Salt River is available. It early developed as a major transportation center. With the

growth of commercial activities Phoenix has become the most popular city in the state. As a response to its location and available labor supply, manufacturing has centered here.

The great distances to market and the meagerness of local raw materials long retarded manufacturing in this area. Finally in 1950, the Motorola Corporation built an electronics plant in the city. This industry produced a high-valued product with a low freight rate per unit. It is also important that this industry did not require large amounts of process water or heavy, bulky low-value raw materials. In order for an electronics industry to prosper, skilled labor is of major importance. Although most of the skilled engineers and technicians must be imported, the area has not experienced a labor shortage. The recruiting of a labor supply appears to have been aided by a number of factors. There is no doubt that the promise of freedom from ice and snow, the outdoor living, and the sunshine were influential in attracting many of the specialists. The isolation proved to be more theoretical than real, for with railroad service, air facilities, the automobile, radio and television, and a population of over 500,000, Phoenix is a modern, urban city.

The success of the Motorola Corporation laid the foundation for the major growth in the electronics and aircraft component industries. Between 1950 and 1960 over 250 new plants located in Phoenix. These factories provided over 15,000 new jobs. In 1960 about 60 per cent of the city's industry was devoted to the production of aircraft equipment and electronics. Because these operations are highly dependent on government contracts, there is considerable interest in the development of a civilian market. However, not all aircraft equipment is used in military planes and guided missiles. The expansion of commercial air service and the changeover by the major airlines to jet craft both mean a larger civilian market. The importance of the business market for electronic equipment was highlighted with the establishment of a computer center by the General Electric Company in 1957. In the electronics field emphasis has been placed on the production of transistors—the first practical substitute for the vacuum tube. The market for transistors is nationwide, for virtually every piece of electronic equipment from the ubiquitous radio and TV set to the most complicated instrument for controlling industrial processes uses transistors. Freight costs are of little importance in marketing this product. The value is so high that a million dollars of transistors may be loaded in a single truck. The stability of the aircraft parts and the electronics industries appears excellent regardless of what happens to defense procurement.

Although aircraft equipment and electronics dominate manufacturing, a number of other industries are growing in importance. One of the most promising of these is the expansion of apparel manufacturing to serve regional and national markets. Since 1950 garment shops have established operations that provide nearly 2,000 jobs. The apparel products include not only staple merchandise for chain store distribution in the West but high fashion sportswear. As the population of the area expands, the local market for certain types of products grows. These new industries include food processing, building materials and furniture.

Ogden-Salt Lake City-Provo. The Ogden-Salt Lake City-Provo District in Utah is one of the oldest manufacturing centers in the West. The earliest settlement of the area began in 1848, one year before gold was discovered in California. This oasis region became one of the major outfitting centers for the westward moving settlers. The earliest manufacturing was concentrated on essentials for a pioneer population. The second phase of development came to the area with the completion of the Union Pacific Railroad in 1869. Transcontinental rail accessibility placed this region in a strategic position for serving the developing Pacific Coast states.

The development of the region's mining industry has greatly influenced its industrial structure. The earliest mine claim was filed in 1863 in Bingham, Utah, about 30 miles southwest of Salt Lake City. This led to the discovery of copper, lead, zinc, and silver, of which the copper mine in Bingham Canyon is the largest and most famous. The reserve of ore in this open-pit copper mine is so large that the mine and town reflect a permanency rarely found in a mining region. A second area

of nonferrous minerals is found at Tintic, 60 miles south of Salt Lake City.

Through the availability of nonferrous metals, smelting has long been a major industry in the area. Within a radius of 30 miles of Salt Lake City is the greatest concentration of nonferrous milling and smelting facilities in the nation. Five smelters treat ore originating in Utah and neighboring states, as well as ore from foreign countries. The Garfield smelter, the largest in the nation, treats principally the output from the concentration mills of nearby Magna and Arthur. A second smelter west of Garfield treats cobalt concentrates from Forney, Idaho. The Midvale smelter is limited to treating lead concentrates and ores. Other smelters are operating at Tooele and Milford. No smelters are located directly in the cities because of limited space, high taxes, and objectionable odors and smoke. The output of the smelters consists of blister copper, lead bullion, and zinc oxide concentrates. These products must be further refined to remove the gold, silver, and other metals. The only electrolytic copper refinery in Utah is at Garfield, which now processes about 50 per cent of Utah's blister copper, yielding a product 99.99 per cent pure. Utah now possesses a completely integrated copper industry.

The iron and steel industry was much later in its development than the smelting of nonferrous metals. The first small modern blast furnace was built at Ironton, near Provo, in 1924. Although the operation remained small for many years it proved the feasibility of making iron and steel in the region. With the demands for iron and steel in Pacific Coast industries, particularly in shipbuilding, during World War II, a major iron and steel industry was built at Geneva, a suburb of Provo. Although the raw materials for this plant largely originate in Utah they come from different parts of the state, and the problem of assembly was of major concern. Coking coal comes from Horse Canyon near Price, about 120 miles southeast of Provo. The iron ore is mined at Iron Mountain, 225 miles to the southwest. This is one of the largest deposits in the West and will supply the plant for decades. The limestone comes from Payson, 35 miles south of the plant. The specific location of the plant was influenced by such factors as the ability to assemble the raw materials from rather distant points, the presence of transportation to market the iron and steel on the Pacific Coast, and the availability of water from Utah Lake. There are few fresh lakes in Utah of sufficient size to guarantee an ample supply of fresh water for a large iron and steel plant.

A completely integrated plant was built at Geneva. Modern by-product coke ovens operate in conjunction with the blast furnaces. The plant originally was designed to produce plate and structural steel for the shipbuilding industry. At the end of World War II, with the subsequent decline of shipbuilding, the plant had to be converted to other types of iron and steel products. The principal conversion problem was in the making of thinner sheets, tubes, and a greater variety of products for industrial use. Although this plant, initially built by the United States Government, was extremely high in cost, it was sold to the United States Steel Corporation after World War II for $47,500,000, about one-fifth its original cost. The increasing demand for iron and steel in western United States, particularly on the Pacific Coast, has created a stable market for iron and steel. It now appears that this industry has a sound future.

The availability of iron and steel within the region has encouraged the development of machinery and metal fabrication industries with not only local but national and international markets. These products include mining and milling machinery, commercial laundry equipment, tanks, and transportation equipment. Recently-developed industries include the manufacture of supersonic ramjet engines and solid propellant rocket engines. The electrical machinery industries are also growing in importance with the manufacture of such products as microwave power tubes and electrical transformers. Future growth is encouraging because of the availability of more types of finished steel, increasing demands in the West, and the trend toward decentralization of industry.

The chemical industry in this area is one of the most rapidly expanding activities. Of the branches of the chemical industry, oil refining is of the greatest importance. Utah's oil production in 1960 was approximately 37,600,000 barrels, almost 10 times what it was three years

earlier. The largest Utah oil field is that of Aneth in the southeast corner of the state. Crude oil pipelines carry oil from the producing areas of Utah, as well as the nearby states, to the Salt Lake region. Within the Salt Lake City area are four refineries, with a capacity of more than 100,000 barrels daily. The refined products are consumed not only in the Utah area but are marketed by pipeline throughout much of the West. A finished product pipeline extends from Salt Lake City to Pasco, Washington, and another pipeline has been completed to Twin Falls, Idaho.

Another aspect of the chemical industry entails the production of sulphuric acid. The major center of production is Garfield, where the industry is associated with the smelting of the copper ore. The output of more than 150,000 tons is consumed by the fertilizer, chemical, and copper-refining industries. Other chemical products include atomic energy fuels and superphosphates.

The Ogden-Salt Lake City-Provo area is situated in Utah's leading farm district. As a result, food processing is a major aspect of the industrial structure. Because most of the products are shipped out of the region, Ogden, the railroad center of the area, has also become the leading city for slaughtering, flour milling and meat-packing. Ogden's stockyards process sheep and cattle on a scale comparable to that of St. Louis. Two large flour mills in Ogden and one in Salt Lake City process most of the wheat from Utah and southern Idaho. The sugar refining industry was one of the first industries of the region. The first sugar beets were grown in 1852 when Brigham Young introduced the plant in order to make the Mormon colony self-sufficient in sugar. The first sugar refinery was built in 1891 at Lehi, south of Salt Lake City. Today a number of refineries produce sugar, which finds a market throughout the West. The vegetable and fruit industry has flourished under controlled-irrigation agriculture. The area has become an excess producer and a canning industry has therefore arisen. In this district there are about 30 canneries producing more than 100 million cans of food per year. The vegetables processed include peas, tomatoes, and beans. In recent years the frozen-food industry has increased greatly in importance.

Spokane. Spokane is the largest city of the Northwest's "Inland Empire." It occupies a strategic position for the convergence of four major transportation routes. Of particular importance, it is the western terminus for the only pass in 200 miles north or south across the Northern Rockies. As a result of its position the city early developed commercial functions.

Manufacturing became important as the resources of the region began to be exploited. The city is situated close to the mineralized and timbered areas of the nearby Rocky Mountains. Besides the processing of lumber, a pulp and paper industry has flourished in the city. Spokane is also noted for its production of ferroalloys. The city is well situated to process the agricultural products of the Palouse, Big Bend, and Spokane valleys and other areas in eastern Washington, Idaho, and western Montana. Flour milling and meat-packing plants have located within the city.

The development of the hydroelectric power resources of the region has accounted in large measure for Spokane's manufactural growth. Seven commercial generating stations have been developed on the Spokane River, a tributary of the Columbia, two of which are within the city limits. As the demands for electricity have grown, the local power supply is augmented by the Northwest Power Pool. The abundance of low-cost electric power has attracted a number of industries. Of these, none is of greater importance than aluminum. The first plant was built in 1941 at Mead, near Spokane. The facilities of the plant have been expanded and in 1960 had a capacity of 176,000 tons of aluminum per year. As a result of the availability of aluminum a large fabrication industry has evolved at Trentwood. Nevertheless, because of the limited market a large part of the aluminum is exported from the area, particularly to California and the Midwest.

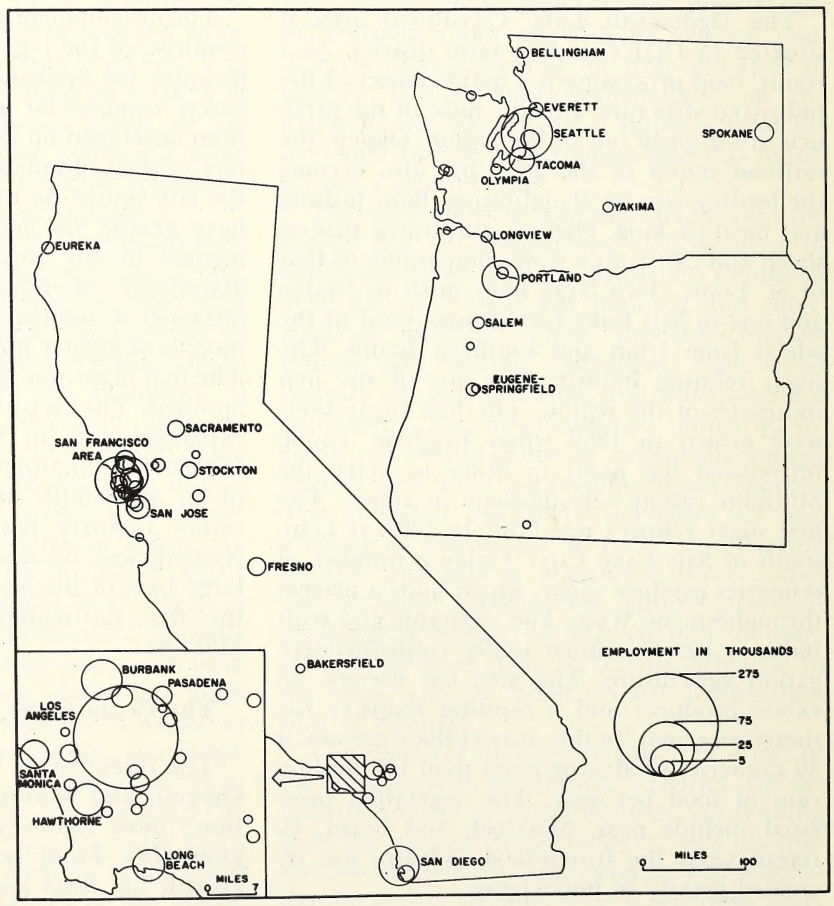
The Pacific Coast

The three Pacific Coast states of California, Oregon, and Washington constitute the nation's most vigorously growing industrial region (75). From Seattle to San Diego the growth has been spectacular, spearheaded by

Los Angeles, where manufacturing is expanding more rapidly than in any other American metropolis. The West Coast is characterized by its concentrated and fragmented geographical pattern, which reveals a few conspicuous focal centers widely separated from one another (Map 2.17). All the large concentrations are located in port cities, either on the coast, such as San Francisco, or on waterways available to ocean vessels, such as Portland.

The region's industrial structure is distinguished by the importance of the food, transportation equipment, machinery, and metal fabricating industries. Average weekly earnings by production workers are among the highest in the nation; only Michigan, Ohio, Indiana, and Nevada have average weekly earnings higher than the three Pacific Coast states.

In contrast to the South, which also is experiencing an industrial boom, the Pacific Coast development is not an "industrial revolution." In the South people are actually changing their occupations, and the regional economy itself is undergoing a change. For decades the South has had a large population supported mainly by agriculture. The revolution has seen a slight population increase, but more significant is the upgrading of their standard of living, abetted considerably by manufacturing's contribution to southern wealth. On the West Coast, however, the industrial boom has not seen westerners change from former occupations to factory work, but rather an influx of new people. It is not a revolution of the economy, it is an addition to the economy. People employed in factories have migrated into the region—not simply transferred jobs within it. The result has been a fantastic growth in population. Thus, the Pacific Coast stands out as an industrial region in terms of its recent rapid growth, its nodal



2.17. United States—Location of Manufacturing in the Pacific Coast.

pattern, proximity of manufacturing cities to the coast, type of industries, earnings by workers, and the population increase it has helped produce.

How much industry? The three Pacific Coast states collectively have over 1,565,000 people employed in manufacturing. This is about 85 per cent of the figure in the New York metropolitan area and only slightly more than that in the state of Pennsylvania. Most of the activity is in California, which has more than 1,215,000 industrial employees. The significant feature is the rate at which the amount of manufacturing is increasing. Since 1899 it has mushroomed more than tenfold, and during World War II the region expanded its employment by 81 per cent, a rate far exceeding the nation's 50 per cent, and the South's 47 per cent. Lest this dramatic increase be overemphasized, it should be observed that the Pacific Coast has only 9.8 per cent of the nation's total manufacturing, about half the South's percentage, only 30 per cent of that of the Middle Atlantic area, and barely one-eighth that of the nation's chief manufacturing belt.

Location of manufacturing. Manufacturing is concentrated in a few communities miles apart, situated like beads on a string (Map 2.17). Five metropolitan settlements contain most of the manufacturing. At the extreme south is San Diego, barely 15 miles from the Mexican border. A distance of 125 miles, containing scarcely any factories, separates San Diego and Los Angeles, the industrial leader of the Pacific Coast. A greater span of 350 miles, with no conspicuous industrialization, lies between Los Angeles and San Francisco. A still greater expanse with little or no manufacturing 600 miles in length lies between San Francisco and Portland. Seattle's cluster of industry lies another 150 miles to the north (43). Industrial centers so far apart probably would not even be considered part of a single region were it not for contrast of the extensive nonindustrialized territory to the east which, like a manufactural desert with few oases, separates the Pacific Coast from the industrial East.

The concentration of industry in a few cities is pronounced. The five major nodes contain 70 per cent of West Coast manufacturing. There is comparatively little industry in small towns or even rural areas as in the South and parts of the East. Conversely, the leading cities of the Far West have outdistanced many eastern and southern cities; for example, Los Angeles has nearly twice the number of industrial plants as Detroit and 35 per cent more industrial employees than Philadelphia.

Los Angeles. Of America's large cities, Los Angeles has been outstripping all others in rate of industrial growth. Between 1947 and 1958 factory employment increased 106 per cent, compared to New York's eight per cent, and Buffalo's and Philadelphia's one per cent each. In that eleven-year period the factories of Greater Los Angeles added 369,000 workers to their payrolls, rising to a total of 728,000. Such growth enabled this booming metropolis to surpass all cities except New York and Chicago in manufactural employment.

Although it is a coastal city, there is little association in Los Angeles between manufacturing and navigable waterways. No water channel capable of floating ships or barges penetrates the settled area except for a brief stretch from Long Beach to San Pedro, which possesses the only harbor facilities in the entire Los Angeles area. This harbor is artificial, resulting from construction of a long breakwater. In a sense, Los Angeles, where a harbor was built to meet the need of a city, is the opposite of such places as New York and Philadelphia, where fine harbors were major assets to urban growth. Los Angeles' factories therefore are inland, and nourished by rail and truck transport. Exceptions are oil refineries in the Long Beach area, linked to one another via barge canals.

The dominant industry in Los Angeles is aircraft production, providing 25 per cent of all manufactural jobs in the metropolitan area (Map 2.14). Moreover in aircraft production Los Angeles is the nation's leader, accounting for 25 per cent of its aircraft employment (47). Several companies comprise the industry, which is located in four widely separated places. The largest node includes North American's factory and the Douglas plant north of Long Beach; another North American plant and a Northrup factory are in the western part. A Douglas plant is near Santa Monica, and the San Fernando Valley contains

two factories, Lockheed and Bendix, in Burbank. Employment in this industry has oscillated sharply in recent years. In January of 1940 it provided Los Angeles with 28,300 jobs. Two years later the number had risen to 125,000. The wartime peak in August 1943 was 272,000, nearly a tenfold increase in three and one-half years. The postwar low of 57,700 occurred in January 1948. In 1960 employment was in the vicinity of 200,000. Since this industry is such an important component of the Los Angeles employment structure, its wide fluctuations in payrolls create an unusual strain upon the city's economy.

Several factors have operated to make Los Angeles the aircraft capital of the United States. The climate provided a maximum number of days for test-flying, and several army and navy air bases were already located in California. More important, however, have been the location of industrial genius plus the presence of sympathetic capital for launching factories which attracted labor from considerable distances. The history of the Douglas Corporation illustrates how one man with ideas can, with encouragement, launch a major industry in a community. "Donald Douglas lived in the Los Angeles area, obtained local backing, and set up his plant in 1923 in an abandoned movie studio in Santa Monica. When the business outgrew these quarters, a new factory was built, but in the same town. The Lockheed enterprise began in a similar fashion. . . . The point may be definitely made that sheer historical chance, the juxtaposition of local engineering talent and available capital, has been one of the most outstanding, and probably the most significant factor localizing the industry." (47)

The apparel industry ranks second to aircraft. Emphasis is on women's apparel and sports clothes. Originally established to meet the demands of the Far Western market, this industry is beginning to tap eastern markets, its main appeal being design and style.

The most famous industry, motion pictures, employs 30,000 people, almost as many as apparel production. This activity is one of the best illustrations of how a locality, once established as an industrial center, snowballs by gathering more and more of that industry. Practically all of the motion pictures manufactured in the United States are produced in the Los Angeles area, which has a near monopoly on the required technical "know how" and human resources. How these came to be concentrated in Los Angeles is a long story involving an initial stage set by nature, on which a sunny climate favored the "shooting" of pictures in the early stages of the industry. Other parts of the country have sunny climates—but no movie industry. Equally important was the type of people who settled the area, people with a pioneer spirit willing to invest in a new idea such as Samuel Goldwyn, the Warner brothers, and others.

There seems no reason why Texas could not have become the movie capital of the world if the early moviemakers had chosen to settle there instead of southern California. Today the products of this industry compose a continuous chain linking Los Angeles with practically every community in the United States, as well as hundreds of foreign cities. A large percentage of the nation's TV films are also produced in Hollywood. At the same time a new trend is developing to make "location" films in foreign lands, thus diminishing the importance of Hollywood as a film capital.

In the drama associated with spectacular industries such as aircraft and motion pictures, it is easy to lose sight of other operations which are significant components of the Los Angeles economy. For instance, the production of fabricated metals, machinery, and foods each provides Los Angeles with as many jobs as does the movie industry (Maps 2.12, 2.15). The most significant contrast with the "glamor" activities is that their market for the most part is restricted to the Far West. The rapid growth in that region's population has created a demand for a host of consumer goods which initially were imported from the East but now are made in increasing numbers in West Coast factories, of which Los Angeles has the largest number. Some of these fabricators have begun to seek eastern markets. For example, the Heatform Fireplace Company was launched in Los Angeles by a businessman who, recognizing the need in West Coast homes for a heating device less pretentious than conventional furnaces, designed a fireplace which would serve not only as a cozy heater for a living room but also as a central

heating plant for a house. Made of steel produced in Baltimore and shipped via the Panama Canal to Los Angeles, the new fireplace sold rapidly, catching the fancy not only of western homebuilders but of those in the East. In time, the movement of steel formed almost a complete circle, going from Baltimore to Los Angeles in sheet form and returning eastward as finished fireplaces to hundreds of buyers in the Midwest and East. Finally, this company established a factory in Baltimore to serve its eastern customers.

However, many eastern metal fabricators, machinery producers, and food processors have opened branch plants in Los Angeles. As a result of this system raw materials are shipped by low freight rates and final processing is performed in western factories.

The growing demands of metal fabricators have encouraged the development of a primary metal industry, including several foundries, steel mills, and even blast furnaces. Henry Kaiser's two furnaces at Fontana were constructed during World War II, securing California iron ore and Utah coal and making pig iron and steel for western factories. The ore comes from Eagle Mountain, 152 miles east of Fontana. The pits, opened in 1948, were located 52 miles from the nearest railroad, necessitating construction of the first significant rail route to be built in the United States since 1926 and the longest built since 1918.

Other industries of less magnitude, yet employing at least 10,000 people and based mainly on the western market, are furniture, printing, auto assembly, and rubber. Here again eastern firms such as Time Inc., Ford, Chevrolet, and Goodyear have established branch plants.

A unique industry in one respect is petroleum refining, with associated chemical industries which have an opposite function to the industries just described. Instead of moving raw materials into Los Angeles for sale, they process the natural resources of the area. Five separated oil fields are located in the southern half of the Los Angeles metropolitan area, of which Signal Hill north of Long Beach and San Pedro are the outstanding producers, characterized by a forest of oil drilling towers, countless pumps, and a typical oil field aroma.

Much of the industry's rapid growth in Los Angeles is attributable to the increase in the demand of West Coast population; but much of this rise in population is, in turn, associated with an expansion in job opportunities in manufacturing. In many instances Los Angeles factories, especially aircraft and motion pictures, have with their job opportunities teamed up with other attracting forces to bring people into the region.

Several problems are associated with Los Angeles manufacturing. One is water supply. Every phase of the urban settlement feels the lack of adequate water resources. The ground water stored in the alluvial materials of Los Angeles bedrock was depleted years ago. No streams here maintain a yearly flow, their courses being merely trickles for most of the year. Water is imported via aqueducts hundreds of miles from Owens Valley to the north and the Colorado River to the east. Factories requiring copious amounts of water face a real handicap. Another obstacle to successful competition on the national market is the distance from the nation's major centers of population. Los Angeles industry consequently specializes in items which can move to the consumer with minimum freight charges—such as airplanes—or which have a high value in proportion to transport costs, such as movie film and ladies' apparel. Another notable problem is a consequence of industry's presence—smog. Los Angeles occupies a setting hemmed in by mountains, fronting on the ocean, and subjected to a circulatory system which produces considerable fog. This fog condition is at its worst when the wind movement is from the west. The fog is blown in over Los Angeles, frequently moving 50 miles inland and filling the basin formed by the mountains. An easterly wind sweeps out the basin, producing much clearer skies. Into an atmosphere already disposed to fog, the increasing number of factories has injected fumes and smoke, aggravating the situation and producing an annoying "smog." Many of the older residents wish that industry had never come to Los Angeles. Although the brunt of public criticism has been levied at factories, especially the oil refineries and foundries, exhausts of thousands of automobiles are also a major contribution to the smog.

San Francisco-Oakland. Fringing much of San Francisco Bay is a cluster of several settlements (such as San Francisco, Oakland, Richmond, Alameda, and Berkeley) known as the San Francisco-Oakland metropolitan area, with about the same number of factory jobholders—190,000—as Milwaukee, Wisconsin. Half the industry is in San Francisco itself while nearly half lies in communities along the eastern side of the Bay.

Food industries, especially canning and preserving, are of major importance. Oakland is one of the few large cities with a considerable canning industry, which processes the hinterland's fruit, vegetables, and fish, notably sardines for shipment to both western and eastern markets. The other food industries such as bakeries and bottling works, produce for local and tributary markets.

Shipbuilding, the area's most dramatic industry, is rooted in private yards such as those of the Kaiser Company on the eastern side at Richmond, as well as in the United States Navy Yards on the San Francisco side. During the heavy defense spending years of World War II, shipbuilding became the area's leading industry. Most of the vessels were freighters and tankers, with the "Liberty" and "Victory" ships probably the most widely known types. No warships are constructed here, although the United States Navy operates a dry dock and major repair base at Hunters Point on the San Francisco side of the Bay.

Machinery and miscellaneous metal fabrication resemble the food industries in employing about the same number of people and producing mainly for a West Coast market. The needs of the western states also support primary metal industries such as foundries and small steel mills. As yet there are no blast furnaces in the area to supply the steel mills, which must import pig iron.

Seattle. Seattle's manufacturing resembles Los Angeles in the dominant role played by aircraft fabricators. The Boeing Company's giant plant in southern Seattle is one of the largest airplane factories in the world. Aircraft fabrication and assembly, accounting for a third of Seattle's manufacturing, is relatively more important here than in Los Angeles, although the California metropolis has about five times as many people producing airplanes. Moreover, Seattle has no major producer other than Boeing, which is there for substantially the same reason that Douglas is located in Los Angeles: a chance combination of favorable factors. A Seattle lumberman began making planes as a hobby. Successful designs and production made for a business which simply outstripped the lumber operations.

Lumber industries comprise Seattle's second type of manufacturing. As was true for Los Angeles' refineries, this is a matter of processing raw materials of the hinterland, but in this case the product is shipped to eastern markets. The lumber industry here produces a considerable surplus above the needs of western consumers.

Portland. Portland has almost as much manufacturing as Seattle but is distinct among the large coastal cities in the absence of one dominating type. The leader, lumber products, employs less than 20 per cent of the area total. Paper and related products are the second distinguishing industry. Both are directly related to raw material supplies, with Portland functioning as an assembly and processing point for natural resources moving from the surrounding territory, on their way to markets in California and the East.

San Diego. San Diego is distinguished by the overwhelming predominance of aircraft production, which is credited with 75 per cent of the city's jobs. Of the community's total employment in every phase of economic activity, aircraft manufacture provides 17 per cent. In few industrial cities is a single industry so important. There is a strong association here with the local United States Navy Base and Air Station, which operates and maintains planes that in many instances have been made in San Diego factories, such as the huge Consolidated plant. This plant is along the waterfront, which enables the Navy's flying boats and patrol bombers to be guided directly into the water. As late as January 1940 the industry was comparatively small, employing about 5,000 people. The World War II peak saw this figure skyrocket to 66,000. In 1961 it was around 55,000.

Industrial structure. Aircraft metal fabrication, foods, and lumber products are the major types of manufacturing on the West Coast.

Aircraft assembly is large-scale enterprise. There is no such thing as a small factory in this business. Huge labor forces are essential. Consequently aircraft production is strictly a metropolitan phenomenon, and the foregoing analysis of major cities has covered nearly all of the Pacific Coast's aircraft industry.

Food manufactures are partly metropolitan and partly small-town. These processors can be divided into two distinct groups: those transforming western produce into goods for an eastern market and those producing for a western market. The leader, canning, is of the first group. Canneries in the three states employ over 60,000 people, processing fruits, vegetables, and some fish. In the second group are bakeries, meat packers, bottling works, and dairies, which have a reciprocal function to that of canneries: wheat, cattle, and extracts flow westward to supply the western market.

The manufacture of wood products is akin to the aircraft and canning industries: all three are mostly for nonwestern markets, thereby bringing money to the Pacific Coast. The manufacture of lumber products provides jobs for almost as many people as does the aircraft industry. A major contrast is that these mills are dispersed throughout the region in countless communities, many of which are small, their very existence depending upon the mills.

The lumber industry in Oregon, Washington, and California employs a total of about 140,000 workers. The function of this industry is relatively simple: logs move from harvest areas to sawmills, where the raw material is transformed into boards, veneer, dust, and scrap. The boards and veneer move on through any one of three channels: a minor amount is marketed in the West; more moves to nearby millwork factories for further transformation into window sashes, casings, or doors; but most of it is shipped eastward toward the major American markets. These markets, though at one time nourished by forests of the East and upper Midwest, now are dependent upon the Far West for the best structural timber and millwork commodities. Douglas fir, white pine, and hemlock—the better woods for these uses —are grown mainly in the northwestern portion of the country. Much of the sawdust is sold for fuel in the local region. Many homes are heated in this manner; sawdust is even used by some communities for firing power plants. However, sawdust cannot bear high transportation costs, and "burning ovens" burn the excess dust at mills situated in sparsely settled regions where demand for dust does not equal the supply.

Circulation of goods in this industry involves a diversity of transportation types. From logging areas in the forests, the logs frequently are floated down flumes and streams to sawmills located at the confluences of watercourses. However, such transport arteries are limited in their penetration of forested areas; moreover their transportability fluctuates with seasonal variations in precipitation and runoff. Consequently other forms of transport carry the burden in areas untapped by large streams. In some places logging railroads meander down steep grades and around tight curves, conveying logs from forest to mill. A comparatively new form of transport in this movement is the truck. Some logging trucks are specialized vehicles adapted to hauling unusually large logs. Each vehicle consists of a prime mover and a wheel mount beneath the front end of the logs, with a rear wheel mount affixed to the rear end. In a sense the log itself constitutes the body of the truck. Such vehicles are common features on highways in the lumbering region.

Location of lumber manufacturing is rather well defined. Most of it is in western Oregon, western Washington, and northern California. Eureka, California is the southernmost of the major sawmill cities. Thus, the industry is distributed in close conformity with forests.

Mill products generally move by rail, although the western market is being served to an increasing degree by truck. Where mills are situated in coastal cities on tidewater sites, some of the products are loaded on ships. A portion of this flow moves to coastal markets in the West, some moves via the Panama Canal to eastern United States, and some goes to foreign buyers.

Communities, supported by sawmills, veneer mills, and millwork factories, almost always are located in a particular type of transport route focus location, the ideal setting being at a convergence of sizable streams flanked by logging railroads and roads capable of bear-

ing logging trucks. Where such a site is on tidewater land, a maximum transport advantage is achieved.

Not only is raw lumber processing a leader in this region; it is also the nation's leading supply area for structural timber, veneer, and millwork materials. Consequently, a steady flow streams eastward via the major railroads serving the Pacific Northwest. The Great Northern, Northern Pacific, Milwaukee, and Union Pacific railroads all move tremendous tonnages of wood products. Lumber commodities provide about 15 per cent of the total freight revenue of these roads, although for the Northern Pacific the proportion is approximately 22 per cent. The flow continues to the Atlantic seaboard. Many of the studs and window sashes found in homes on the East Coast have been processed from Pacific Coast lumber.

The future of this industry depends directly upon the ability of western people to conserve forest resources. The careless and excessive harvesting of trees which characterized the exploitation of northeastern United States can be avoided in the Far West. Certainly the ways and means for intelligent cropping of trees have now been demonstrated; the custodians of western forests must learn the principles and apply them if the resource base of this major industry is to be maintained. Careful cutting so as to leave adequate forests for reseeding and restocking where necessary are just two conservational practices which can insure a steady crop of trees. That this is accepted as the concern of more than just the landowners is evidenced by the state of Washington, which deems it permissible to order landowners to restock cut-over areas. Landowners challenging these edicts have found the state's supreme court supporting the order. One case actually went to the United States Supreme Court and terminated with the highest court in the land ruling that a state is justified in ordering landowners to restock cut-over land. But conservation of the resource can be difficult if the tremendous pressure of increasing demands continues. An increasing domestic demand is attributable to the boom in housing construction and a decline in imports, some of which formerly came from Canada and Scandinavia but which now go to Western Europe. There has also been an increase in foreign sales.

Metal industries are comprising an increasing share of Pacific Coast industrial effort. In the past, western customers were supplied almost entirely by eastern producers. Machinery, refrigerators, stoves, and other items were imported from the East. Then fabricating plants were established locally. The proportionate flow of consumer goods from the East decreased, but steel and other materials for the new fabricators increased. The next step was the establishment of western steel and aluminum mills. The final step was the construction of blast furnaces. Now, the Far West produces many of its own consumer metal goods, fabricated in factories which consume aluminum and steel that are also made in the West, with some of the steel being made from pig iron smelted in the West. As yet the only primary iron and steel works is Kaiser's plant at Fontana, California. Steel mills also are in the San Francisco area. Aluminum is produced in the Northwest. Although this industry is new in the region, it now accounts for 25 per cent of American aluminum production. The Reynolds plant at Troutdale, Oregon has about 7 per cent of the national capacity, while four Washington plants, Kaiser's mills at Tacoma and Spokane, Reynolds at Longview, and Alcoa at Vancouver, account for 18 per cent. The West Coast's aircraft factories depend on these plants for the aluminum used in plane construction.

Other industries include a wide diversity of production for the western market: apparel, furniture, paper, publishing, chemicals, rubber, leather, pottery, and glass. A few of these have reached beyond their regional market to attain a national one, such as sportswear from Los Angeles.

Relationships. The growth in West Coast manufacturing is the result of several factors. The rapid increase in population has generated buying power, which has attracted considerable local manufacturing to it. However, much of the population growth has been predicated on expanding job opportunities in nonlocal industry—that is, manufacturing not dependent on sales to the local areas. Leadership in this fundamental type of manufacturing has been the aircraft, ship, lumber, canned

goods, and motion picture industries. These are the major manufactures "exported" by the West Coast. One must recognize too that many job opportunities have been provided by agriculture, mining, lumbering, trade, and government: all of which abetted an increase in population and a larger market for manufacturing.

A second causal factor has been power. Hydroelectric dams, especially in the Columbia River system have produced a commodity to lure considerable industry. This is the main reason for the location of aluminum mills and the atomic energy factories in this region. Largest dams in the Far West are Grand Coulee, Hoover, and Mt. Shasta.

Effects of the industrial boom have been varied. Competition for labor has produced some of the highest levels of average hourly earnings for industrial production workers in the United States. As a result of increased population there has been a growing demand for more housing. Cities have expanded rapidly, with real estate subdivisions and new construction advancing like conquering armies into the orange groves of southern California and the truck farms and forests of the Northwest.

The future. The fantastic industrial growth of the Pacific Coast at a rate exceeding every other region in the nation cannot be expected to continue, at least in the light of man's present industrial knowledge. Two critical factors place ceilings on manufacturing expansion here.

One is power shortage. The demand for electric power is great, not only from power-consuming industries such as the plutonium factory at Hanford, Washington, but also from residential and commercial consumers. Moreover, the West depends upon hydroelectric plants for most of its power; cheap coal is not at hand. Variation in precipitation therefore handicaps the power supply. Already the Northwest has harnessed most of its hydroelectric power resources.

A second limitation is availability of water. Limited water supply restricts not only manufacturing but also population. This factor is an obstacle only to the southern half of the West Coast, whereas the power shortage applies throughout.

In view of these handicaps it is not surprising that the industrial expansion in the Pacific Coast is slackening. Since 1950 the Texas and Gulf Coast areas are receiving more new industry than the Far West. One reason is that Texas has power, in the form of natural gas. Also, plants can be located farther inland, which may have a strategic value. In any case, the future industrialization of the Far West probably will increase less rapidly—unless the power and water problems can be solved.

Solution to the water shortage will come when a method is applied to convert sea water into fresh water cheaply. Then the Far West will suddenly become a region of surplus. Solution to the power shortage may come with a method for producing electricity from coal in Utah and transmitting it to the Coast. Or perhaps some new discovery adapting atomic power to industry may be the solution.

Growth of manufacturing has been associated with an increasing demand for consumer goods from the expanding West Coast populace, and increasing production for other markets of lumber, foods, motion pictures, aircraft, and ships, in all of which the region has either natural resources or locational advantages which an aggressive citizenry has exploited.

CANADA

Canada is one of the world's major manufacturing nations, probably ranking sixth or seventh. Manufacturing contributes approximately 30 per cent of the net national income, which is nearly the same proportion that manufacturing holds in the United States. About 30 per cent, or over 1,350,000 of the employed population, are in manufacturing.

Factors of industrialization. A number of factors have been influential in the development of Canadian manufacturing. Of primary significance has been the availability of vast natural resources. Agriculture has provided the foundation for major food processing industries. The mammoth deposits of nonferrous metals, iron ore, and petroleum have motivated manufacturing in many regions. For example, the petroleum fields of Alberta have provided the raw material for a significant petrochemical industry. The massive smelting and metal

refining industry is based fundamentally on these extensive deposits, but their rapid exploitation is due to abundant low-cost hydroelectric power and easy access to world markets.

International conditions have favored the growth of many types of manufacturing in Canada. During the World Wars and the Korean War manufacturing expanded at a rapid pace. Throughout these periods, the major portion of capital expenditure went into establishing industries that aided the defense program. The capacity of the plants to produce such items as aircraft, electronic equipment, ships, and guns was greatly enlarged. Many commodities were produced during these periods of stress which had never before been manufactured in Canada. The industrial economy of the nation was directed toward established national goals. Measures such as controlling the use of raw materials—particularly steel, credit regulations, and deferred depreciation legislation, created an economic environment favorable to the growth of basic industrial capacity. However, once the basic war industries were established they were soon converted to peacetime production at the conclusion of hostilities.

The growing world demand for raw materials is playing a significant role in molding the Canadian economy. It is based on a rising curve of employment and income in the world and accentuated by the course of international events. These trends, particularly dynamic since World War II, show no signs of lessening and have led to substantial increases in Canadian primary manufacturing capacity, particularly for light and nonferrous metals, chemicals, pulp, and paper.

The present growth patterns of Canadian manufacturing are also strongly influenced by the expanding domestic market for Canadian products. The domestic market has been influenced not only by the growth in total population but also by the rising standard of living. Many new plants have been built in Canada to supply the domestic market. Canada is now essentially self-sufficient in such products as textiles, plastics, petrochemicals, and many types of machinery. As a result of the rising income levels there has been a steady rise in the quality of the manufactured goods. For example, in food processing the rise in quality of the foods sold on the domestic market has been more important than the increased production required by the expanding population. The two factors together about doubled the dollar sales of processed foods in the country between 1945 and 1960.

Industrial structure. The industrial structure of Canada has become increasingly complex. Manufacturing was long dominated by the processing of domestic raw materials. In recent years the engineering and chemical industries have grown in importance. As manufacturing has become more complex it has also become more diversified. Manufacturing now extends to virtually all lines of consumption, except some specialized types of capital equipment (117).

Of the Canadian industries, pulp and paper has long held first place. This industry is based on the tremendous reserves of coniferous forests, streams for transporting the logs, hydroelectric power, and a huge export market. The availability of large quantities of low-cost hydroelectric power is recognized as a major localizing factor, for this industry consumes about 33 per cent of all electricity used by Canadian manufacturing. There are about 125 pulp and paper mills in Canada, of which nearly 100 are in the provinces of Ontario and Quebec. Most of the mills are extremely large. Although paper from rags has been made in Canada since 1803, it was not until 1866 that wood became the major raw material of paper. At first the industry grew slowly, but as the timber resources of northwestern United States were gradually depleted, and after the customs duty on newsprint was abolished in the United States in 1913, the Canadian newsprint industry grew rapidly. In 1913, the production of newsprint in Canada amounted to only 350,000 tons. By 1929 the output had increased to 2,725,000, and after a short period of decline during the 1930's, the industry continued to expand, with a present-day output of about seven million tons of newsprint annually. The pulp and paper industry has an annual value of shipment of about $1,500,000,000 and employs about 70,000 workers.

The petroleum industry and associated chemicals are now the second largest in

Canada, having advanced from fifth place in 1949 to second in 1957. The Canadian refining industry processes more than 270 million barrels of oil annually, of which between 55 and 60 per cent is from Canadian wells. The traditional refining centers of the Maritime Provinces, Ontario, and Quebec, are market oriented. The refineries of Quebec and the Maritimes continue to utilize foreign petroleum because of their distance from Canada's western oil fields. With the recent construction of petroleum pipelines from Alberta to Ontario there is a growing consumption of Canadian oil by the Ontario refineries.

The nonferrous smelting and refining industry is Canada's third largest manufacturing industry. Canada is one of the world's leading producers of nonferrous metals, standing first in output of nickel, second in aluminum, third in zinc, fourth in lead, and fifth in copper. This industry is based primarily on Canadian ores. The major exception is the aluminum industry, which must import bauxite and alumina, and depends on low-cost hydroelectric power for successful operation. The Canadian smelters and refineries are among the largest and most highly integrated of their kind in the world. Canada is the world's leading exporter of nonferrous metals.

With the demand for metals by the mechanical and engineering industries, the primary iron and steel industry has experienced considerable expansion. It now ranks sixth among all industries in terms of value of output, fourth in terms of value added, and, with a labor force of 36,000, is the third largest employer. The steel industry of Canada traces its origin to the many small furnaces of eastern Canada that developed about 1730. The first steel was produced in Canada in 1874 and in the next 30 years the present pattern of iron and steel production evolved. The early growth of the steel industry was greatly influenced by the demand for steel by the expanding railway system and the development of a national protective tariff. The annual steel capacity of Canada grew from 1,600,000 tons in 1918 to 2,200,000 tons in 1949. By 1960, it had reached about 6,300,000 tons. In per capita capacity Canada ranks sixth in the world, and in per capita consumption Canada is exceeded only by the United States. The blast furnace centers of Canada are Sydney, Nova Scotia and Hamilton, Port Colborne, and Sault Ste. Marie, Ontario. Major steel furnaces and rolling plants are located at Sydney, Nova Scotia; Montreal, Quebec; Hamilton, Welland, and Sault Ste. Marie, Ontario; Selkirk, Manitoba; Edmonton, Alberta; and Vancouver, British Columbia: The expansion of the rolling mill capacity in Canada has been a noteworthy feature of the industry in recent years. In 1945 Canada could produce 356,000 tons of hot rolled sheet and strip; in 1960 Canadian mills had a capacity in excess of one million tons.

The metal fabrication and engineering industries have experienced a rapid rise in recent years. Of these industries, motor vehicle output is most important, ranking fourth in value of output and number of employees of all Canadian manufacturing. Annual production of passenger cars totals between 300,000 and 375,000, and trucks total about 80,000. The Canadian aircraft industry has experienced wide fluctuations in output since 1940. Production was of major importance during World War II, but declined abruptly afterward. As a result of the demand for aircraft created by the Korean War, output once again increased and has been maintained at a high level. Features of the expansion include the development of an all-Canadian long-range fighter for defense of the north. However, the industry is not dependent entirely on the defense program. Several types of civilian aircraft have been developed to meet Canada's unique Arctic flying conditions. The railway rolling stock industry is Canada's tenth leading industry. However, its relative importance is gradually declining. The output of this industry depends on the demands of the railways for new equipment and replacements. With the growing importance of truck transportation, the railways are no longer as important as transporters of goods or passengers. The electrical apparatus and machinery industry has recently made rapid strides. Output of heavy electrical machinery totals more than $300,000,000 annually and electrical appliances have an output of about $400,000,000.

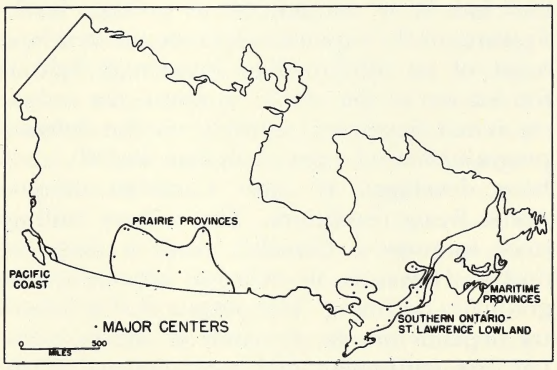
The food processing industries are traditional to the Canadian industrial economy. Of these, slaughtering and meat-packing are most

important. Butter and cheese are next in importance of the food products, followed by miscellaneous food preparations and bakery products. The relative importance of these industries is gradually declining. The demand for food is not rising as rapidly as the demand for capital goods products.

The lumber industry has been a mainstay of Canada's economy since the pioneer period and at present ranks as the seventh largest manufacturing industry of the country. Of the lumber sawed, over 60 per cent by value is produced in British Columbia, about 16 per cent in Quebec, and 12 per cent in Ontario. Softwoods make up 95 per cent by quantity of lumber sawed. The decline in the export demand for Canadian sawmill products in the early 1960's caused a drop of about 15 per cent in the physical volume of production.

Manufacturing Regions

The major industrial axis of Canada extends from Windsor through Toronto and Montreal and on to the city of Quebec (116). This area is designated as the Southern Ontario and St. Lawrence Lowland Region. It



2.18. Canada—Manufacturing Regions of Canada.

is here that the thriving industrial economy of Canada has made the greatest progress, and this area contains more than 80 per cent of the nation's manufacturing. This region enjoys unique advantages as the industrial heart of the nation. This is not only the pivotal center of the population of Canada, but the rural movement to the cities has supplied an expanding industrial labor force. The area has also been able to recruit part of its labor force from European immigrants as they enter the nation.

Probably no other part of equal size in North America has a superior network of transportation facilities. The Great Lakes and St. Lawrence waterways and a dense network of railroads and roads comprise a transportation system which links this area with the major traffic lanes of the ocean and the land routes of the continent. The relation of industry to transportation lines is clearly shown in the alignment of cities along the waterways and the railroad lines. The dense transportation pattern provides easy access to the area. The lowlands are like a trough into which pour the ores, pulpwood, and timber of the Canadian Shield, the wheat and petroleum of the Prairie Provinces, and the coal, food products and wood of the Maritimes. Raw materials from the United States or from overseas move readily into this processing area. Whereas this region possesses no coal, it does have tremendous reserves of hydroelectric power from Niagara Falls, the St. Lawrence River, and the nearby Shield. The Nova Scotia coal deposits are a long way from this area, but the Appalachian fields of the United States are relatively near.

A number of smaller manufacturing regions are in the process of developing in Canada. Nodes of industrialization have evolved in the Maritime Provinces. In the Prairie Provinces, Winnipeg is the traditional industrial center. In recent years with an expanding market and the discovery of petroleum in the western Prairie Provinces, industry is thriving in such centers as Edmonton and Calgary. In western Canada, the Vancouver area is the leading center. Isolated nodes of manufacturing include the smelting and refining center of Trail and the aluminum town of Kitimat.

Southern Ontario and the St. Lawrence Lowland. This region has a long tradition of manufacturing. The initial industry was based essentially on the raw materials available in the area. The processing of furs was the earliest activity, followed by a thriving lumber business. Because the lumber trade was dependent on the natural transportation routes afforded by the rivers, exploitation of the

forests began along the banks of the St. Lawrence, and advanced into the interior along its major tributaries, particularly the Ottawa River. The town of Hull, opposite Ottawa, exported timber as early as 1806. Lumber and timber continued to be the main export of the region until the 1860's.

Agriculture orientation. With the clearing of the Great Lakes forests and the St. Lawrence Lowlands, a diversified agriculture evolved. The processing of agricultural commodities gradually became important and by 1871 flour and grist mill products were the leading industries in Ontario and Quebec. The farms also provided the raw material for the tanneries and the wool textile industry. Boots and shoes, apparel, distilleries, and bakeries were also important industries by 1871. The agricultural economy gradually created a demand for other manufactured goods. Consequently, foundries and machine shops produced iron and steel products for the rural economy on a modest scale.

By 1871 the Ontario-Quebec area had secured a dominant position in manufacturing in Canada (98). The value of manufactured goods from its ten leading industries was $76,969,000 as compared with $13,541,000 for New Brunswick, the leading Maritime Province. A number of factors led to the growth of manufacturing in the lowlands of Ontario and Quebec. The agriculture of this area was the most productive in Canada. This led to a greater quantity of agricultural raw materials to process. For example, in 1871 flour and grist mill products were among the ten leading types of manufacture in Nova Scotia, New Brunswick, Quebec and Ontario, but the value of output in Ontario was over $27,000,000 and in Quebec nearly $10,000,000, compared to $1,000,000 in Nova Scotia and New Brunswick. At the same time, the agricultural products of the Ontario-Quebec farms required more processing than did the primary products of the Maritimes. The large number of distilleries in Ontario reinforces the concept that agricultural products provided the basis for the manufacturing economy. In the Maritime Provinces, by contrast, fish processing was a simple operation and many of the agricultural products, such as potatoes and apples, required no processing. The shipbuilding industry, based on local timber, was the major exception in the Maritimes, but this industry failed to provide the base for manufacturing that agriculture provided in Ontario and Quebec.

Other factors were also important in the development of the manufactural economy of Ontario and Quebec. The prosperity of agriculture led to greater capital investment on the farms. As a result there was a larger market for agricultural implements in Ontario and Quebec than in the Maritimes. In 1871, 85 per cent of the total output of agricultural implements of Canada were produced in Ontario, and nearly the whole of the remainder in Quebec. Also of considerable importance in the manufactural growth was the expanding population. The Ontario-Quebec area became the major center of population and the larger population enhanced the market potential. Finally, this area was most favorably situated to export to the United States. Gradually a thriving export trade developed between the two nations.

An evolving industrial complex. In the period between 1870 and World War I a number of changes occurred in the manufacturing economy of Ontario and the St. Lawrence Lowland. A major influence on the evolution of the manufacturing in the area was the decline of diversified agriculture and the development of specialized dairy farms. Although flour and grist mill products remained the leading industry in Ontario in 1911, much of the wheat was no longer grown locally, but was imported from the Prairie Provinces for processing. In Quebec, flour and grist mill products declined from first place in 1871 to eighth place in 1911. In contrast the dairy products industry grew rapidly. For example, the introduction of the first cheese factory in 1864 was followed by a rapid growth. By 1871 there were 353 cheese factories in Ontario and Quebec and by 1911 there were 3,390 factories. In the period from 1871 to 1911 the value of these products increased 20 times and employment by nearly six times. By 1911 butter and cheese was the fourth leading industry of Quebec and held seventh place in Ontario (98).

Forest products remained of major importance to the manufactural economy of the region. However, a significant change in the

market for forest products was beginning to appear. Log and sawmill products still retained the greatest value, but pulpwood for pulp and paper was growing steadily in importance. The growing demand for newsprint in the United States and Canada resulted in the expansion of the pulpwood industry. Initially there was little export of pulpwood to the United States, for this nation was able to supply its own pulpwood requirement until about 1900. Gradually the export demand for pulpwood grew so that by 1908 more than two-thirds of the pulpwood cut in Canada was shipped to the United States. In order to protect the infant Canadian paper industry an embargo was placed on exporting the pulpwood from the crown lands of Ontario in 1900 and of Quebec in 1910. With these acts, and later measures, the proportion of pulpwood exported to that consumed domestically declined rapidly. By 1911 paper production had risen to ninth place in the industries of Quebec.

Other significant changes in the industrial structure of the area were the growing differences between Ontario and Quebec. In Ontario such heavy industries as foundry products, iron and steel, and machinery were increasing in importance. In 1871 these products made up about 11 per cent of Ontario's manufacturing. By 1911 their share had grown to 29 per cent. The heavy industries were thus expanding more rapidly than the light industries in Ontario. In contrast, a reverse trend was occurring in Quebec with the rapid expansion of the light consumer goods industries. In this province, foundries and iron and steel products disappeared from the list of the ten leading types of manufacture. The cotton textile and the tobacco industry became firmly established and the production of clothing and boots and shoes remained significant. The differences in the types of manufacturing between Ontario and Quebec have been due to a number of factors. There was a greater market in Ontario for metal products than in Quebec because of the demand for such items as agricultural machinery, and also because Ontario was supplying most of the equipment for the settlement of western Canada. Ontario industrialized more rapidly than Quebec so that labor was more expensive and higher value-added industries were emphasized. In Quebec a major source of labor was from the poor rural areas. A large percentage of this labor force was made up of women, who were best utilized in such light consumer industries as apparel and food processing.

Modern industrial structure. A number of significant trends have occurred in the manufacturing of this region in the past half century. Possibly the most significant trend is the magnitude of the shift toward industrialization. The annual value of manufactured products in Quebec increased from $766,000,000 in 1917 to over $6,000,000,000 in 1960. In Ontario the rise was just as significant, going from $1,456,000,000 to over $10,000,000,000. Employment in manufacturing rose in Quebec from 188,000 in 1917 to over 450,000 in 1960; in Ontario manufactural employment rose from 300,000 to over 600,000.

The industrial composition of the region has also been gradually altered. The rise of new and the decline of the older export commodities have changed the ranking of major industries. Of the new export industries none are of greater importance than that of newsprint and nonferrous metals. Prior to World War I the export of pulp and paper was in its initial stage. Primarily as a result of the United States market the newsprint industry has expanded to a major industry in the region, with an annual output valued at $1,400,000,000. Canadian export of newsprint to the United States has averaged over $500,000,000 in recent years.

The two provinces of Ontario and Quebec with about 100 pulp and paper mills have one of the largest concentrations in the world. A number of pulp and paper districts can be recognized. The principal development occurs along the St. Lawrence Valley where 33 pulp and paper mills are found, with the largest number in the area between Montreal and Quebec. The three major northern tributaries of the St. Lawrence, the Ottawa, St. Maurice and Saguenay, have each developed concentrations of pulp and paper mills. The western end of Lake Ontario possesses 17 pulp and paper mills with Toronto the leading center. In the highlands of southern Quebec seven pulp and paper mills are situated in the area of Lennoxville, East Angus, and Kingsey

Falls. As the demand for paper has grown, the industry has moved northward and westward in Ontario following the main railroad routes. Large plants are now located in Kapuskasing, Iroquois Falls, Espanola and Sault Ste. Marie.

The pulp and paper industry is primarily situated between the chief sources of pulpwood to the north and the major markets to the the south in the United States. This region is not only accessible to rich sources of spruce, balsam and hemlock, the best wood pulp raw materials, but has the hydroelectric power so essential to the manufacture of pulp and paper. Few industries have so large and constant a market, for many of the great daily newspapers in Anglo-America use Canadian newsprint.

The development of the region's mineral economy is equally as impressive as that of pulp and paper (110). The nonferrous metal smelting and refining industry is the third largest industry in Quebec and the fourth industry in Ontario, with a total annual output from the two provinces of $1,500,000,000. The southern edge of the Canadian Shield has developed as one of the major areas in the world for the production of copper, nickel, zinc, gold, silver and a number of other minerals. With the development of mining, the processing of the ores began in the mining district. The universal practice with gold bearing ore is to treat the ore and recover the metal at the mine site. With the growth of base metal mining, smelters were established to reduce the bulk of the low metal content ores. These smelters are thus raw material oriented. The major smelter center is at Sudbury where three copper-nickel smelters are located. A second smelter center is at Noranda, for processing the copper ores of the Quebec District. The newest smelter in the area began operation in 1954 to process the cobalt-silver ores at Cobalt.

Because of the tremendous production of copper at Sudbury and the availability of low-cost hydroelectric power, a copper refinery has been constructed in the Sudbury District. However, since little copper is utilized for manufactured products in the mining region, large quantities of anode copper are sent toward the market to be refined in southern Ontario and the St. Lawrence Valley. A mammoth copper refinery exists at Montreal East. This plant treats the entire output of anode copper from the Noranda, Flin Flon, and Murdochville smelters. Gold, silver, selenium and tellurium, which are contained in the anodes, are recovered during the refining process. The refinery, with an annual capacity of 275,000 tons of refined copper, is the second largest in the world.

A nickel refinery developed at Port Colborne near Niagara Falls because of available transportation facilities and power supply, and a cobalt-silver refinery is located at Deloro, Ontario. Because of the availability of large quantities of low-cost hydroelectric power, three major centers of aluminum production have developed at Arvida, Shawinigan Falls, and Beauharnois in Quebec (108). The raw materials for these plants are imported, and the aluminum is shipped not only to all parts of Canada but the world market. The localizing of aluminum manufacturing in this region illustrates most effectively the influence of low-cost electric power on the location of this industry.

Although the processing of the area's raw materials is of great importance, a major industrial complex has evolved in the region. The metal industries have become increasingly important. The manufacture of transportation equipment, predominantly motor vehicles and rolling stock, is Ontario's leading industry, followed by iron and steel products, including machinery. The metal industries comprise 45 to 50 per cent of Ontario's manufacturing, but only about 25 to 30 per cent of Quebec's total. The concentration of metal industries in southern Ontario is explained largely by the availability of fuel and power. Although neither Ontario nor Quebec possesses coal, the proximity to the Appalachian coal fields has given Ontario the locational advantage for industries dependent on large quantities of heat.

The major district for metal industries is found in a group of cities clustered around the western end of Lake Ontario from Oshawa through Toronto to Niagara Falls. This is an almost continuous urban belt, including such large cities as Hamilton, St. Catharines, and Brantford. The area is the most intensive in-

dustrial concentration in Canada. A broad band of metalworking cities extends across southern Ontario, including Woodstock, London, and Chatham, to Windsor, an industrial concentration on the St. Clair-Detroit rivers. Another concentration of metal industries is found along the St. Lawrence Valley, with its major center at Montreal.

The region's primary iron and steel industry is located at Hamilton, the most important steel center in Canada (106). The first iron and steel plant was constructed in Hamilton in 1895, and the modern expansion of the industry dates from 1910, when the Steel Company of Canada was formed. It has grown to be the largest steel company in Canada, with more than 50 per cent of the total Canadian output. A second steel firm, Dominion Foundries and Steel Company, founded in 1917, produces nearly 15 per cent of the nation's steel. The location of the steel industry in Hamilton reflects a market orientation similar to other Great Lakes steel centers in the United States, such as Buffalo and Chicago. Its position is essentially halfway between iron ore and coal as well as close to the market. Most of the iron ore comes from the upper Great Lakes deposits, and the coking coal from Pennsylvania and West Virginia. The Steel Company of Canada owns coal mines at Coalwood, West Virginia and Hillsboro and Mather in Pennsylvania and iron mines in the Mesabi, Gogebic, Menominee, and Marquette ranges. With the decline of iron ore reserves in the United States portion of the upper Great Lakes, this company has become interested in the development of the taconite deposits of Minnesota, and in the newer Canadian iron ore sources at Steep Rock, Ontario and the Ungava deposits of Quebec-Labrador. The scrap for the steel furnaces is provided by the industrial towns of southern Ontario, and limestone is quarried nearby. About 60 per cent of Hamilton's iron and steel is marketed in southern Ontario, 20 per cent goes to Quebec, mainly to Montreal, and another 20 per cent is shipped to northern Ontario and western Canada.

The development of the chemical industry in this region is also noteworthy. Montreal in Quebec and Sarnia in Ontario are the leading centers. Of the chemical industries, petroleum refining is most important. Montreal is the largest petroleum refining center in Canada. Originally all oil came from outside the country, primarily Venezuela; but in recent years petroleum from western Canada is becoming increasingly important. During the open-water period tankers with foreign petroleum come directly to the refineries. During the winter, however, when the St. Lawrence River is frozen, the oil is brought by pipeline from Portland, Maine. A newer but rapidly growing petroleum refining center is situated at Sarnia. This center, originally supplied from local oil fields, now depends on petroleum from western Canada brought by pipeline. Besides petroleum refining, a growing petrochemical industry has been established.

A major trend in recent years has been the growth of a wide variety of industries that are based primarily on a domestic market. Many of these industries survive foreign competition only with the aid of a protective tariff. A number of these industries are based on imported raw materials, such as cotton. Notable in this development has been the establishment of foreign branch plants, mainly from the United States. Important examples of this type of industry are the large number of metal products, such as automobiles, farm machinery, electrical equipment, and many others. These manufacturers, producing articles by mass production methods, have found it advantageous to have branch plants in Canada for a number of reasons. The branch plants are within the Canadian tariff barrier and thus not only have duty-free access to an expanding market but also enjoy the preferences reserved for the Dominion in the British Commonwealth of Nations. A number of United States manufacturers find it desirable to maintain Canadian factories in order to have direct access to Canadian raw materials. The Canadian government has encouraged the establishment of United States branch plants by providing inducements such as a liberal tax policy. The physical operation of these plants occurs in Canada, but the capital and much of the technical know-how is imported from the United States.

Maritime Provinces. Manufacturing in the Maritime Provinces is of a much smaller amount than in the Southern Ontario-St. Lawrence Lowland and no significant indus-

trial region has evolved. Industry is located in cities that are widely separated such as St. John, Halifax, and Sydney. Only about 10 per cent of the labor force in the Maritime Provinces is engaged in manufacturing. A much greater proportion is employed in primary occupations such as fishing, farming and mining. Much of the manufacturing is based on local raw materials. Industrialization has remained limited largely due to a small local market and a relative inaccessibility to the remainder of Canada.

Lumbering has long been a major industry in this region. Early lumbermen penetrated the virgin deciduous-coniferous forests, selecting the great trees to be used as masts and timbers for large wooden vessels. In 1871 shipyards were the major industry in Nova Scotia and the second industry of New Brunswick. With the decline of the wooden vessel the importance of the shipyards also diminished. For example, the number of men employed in the shipyards declined from just over 2,000 in 1871 to only 450 in 1911 (98).

Lumbering has continued to be so intensive that the virgin forests are essentially gone. Nevertheless, forests still occupy two-thirds of Nova Scotia and nearly 90 per cent of New Brunswick and Newfoundland. With the depletion of large timber trees, the cutting of smaller trees for wood pulp has greatly increased. Some of the pulpwood is exported, but most is consumed by an expanding pulp and paper industry. The growth of the pulp and paper industry has been most spectacular in New Brunswick. In 1911 it had a value of only $1,149,000, but in recent years the annual output has been between $90,000,000 and $100,000,000. Most of the pulp and paper plants of the Maritimes are located in coastal towns such as Edmundston, Dalhousie, Bathurst, St. John, Wolfville, and Liverpool. Each of these plants receives a supply of pulpwood from its immediate hinterland, and is situated to export the finished paper by low-cost water transportation. Although lumbering has declined relatively, it remains an important industry in the region, with hundreds of small sawmills and a few large ones. It is New Brunswick's second industry, exceeded only by pulp and paper, and it is the fourth major industry of Nova Scotia.

Fish processing is one of the oldest activities in the Atlantic Provinces. It is based primarily on the nearby Grand Banks and on coastal fisheries. This area was brought into the economy of the Western world at the outset of the sixteenth century because of these fisheries. The industry has persisted to the present day. Fish curing and packing is an extremely decentralized industry, with over 350 plants scattered along many hundreds of miles of coastline. Digby, Lockeport, Shelburne, Lunenburg, Halifax, Canso, Yarmouth, North Sydney, Pictou, and Blacks Harbour are among the most important fishing centers. Fish processing is now Nova Scotia's second leading industry and the third industry of New Brunswick.

Other important food processing industries in the area include slaughtering and meatpacking, butter and cheese, bread and other bakery products, and miscellaneous food preparations. The industry of Prince Edward Island is dominated by food processing, particularly dairy products. Charlottetown is the major distribution center. The Annapolis Valley of Nova Scotia is noted for its fruit products, especially apples.

A noteworthy development in the region's industrial structure has been the growth of the iron and steel industry in Sydney, Nova Scotia. The availability of large reserves of metallurgical coking coals has been the major factor in the establishment of this industry. On Cape Breton Island a coal field extends for about 30 miles along the shore of the Atlantic Ocean and a large portion of the coal mined comes from submarine workings which lie as far as two and a half miles offshore. The steel plants are situated on the coast in order to secure iron ore from Newfoundland and to export iron and steel, not only to the Canadian market, but also to foreign countries. The primary iron and steel industry is now the leading industry of Nova Scotia, measured by number of employees and value of product. Largely because of the availability of steel, a number of metal fabricating and engineering industries are developing in the Maritime Provinces. One of the most important of these is shipbuilding. Major shipbuilding yards are now located at Halifax and St. John.

The Halifax and St. John areas are the leading and most diversified centers of manufacturing in the Maritime Provinces. The most important industries of these cities are petroleum refining, food (including the processing of imported tropical products such as sugar and spices), pulp and paper, and machinery. Less important centers of manufacturing include New Glasgow, producing steel and rolling stock, Moncton, with textiles, railway shops and food processing, and Truro, with textiles and dairy products.

Prairie Provinces. Manufacturing in the Prairie Provinces is traditionally related to the processing of agricultural products. As a result of the availability of wheat and livestock, flour mills and meat-packing developed at an early date. As the economy of the area grew, more flour, meat, cheese, and butter were processed than could be consumed in the region, laying the foundation for a large and flourishing export trade.

The industry of the Prairie Provinces has evolved primarily in the twentieth century. Until World War I the manufacturing was of the type expected of a young, agricultural region dependent on rail transportation. For example, in 1911 slaughtering and meat-packing, Alberta's major industry, had an output of only $4,030,000. In Manitoba, flour and grist mill products were the leaders with a value of $11,660,000. With the growing world demand for food, the output of food has expanded greatly since World War I. Food and beverage products from the Prairie Provinces in recent years have been valued at from $600,000,000 to $650,000,000 annually. These products comprise over 40 per cent of the region's manufacturing.

Besides the processing of agricultural raw materials, other industries have developed, primarily directed toward the needs of agriculture. Such manufactured products include agricultural machinery, fertilizer, bags, and construction equipment. Because the railroad has been of utmost importance in the development of the region's economy, the railway rolling stock industry is of major significance. In Manitoba it is the largest single employer of industrial labor, with over 6,000 employees. Slaughtering and meat-packing is second with over 2,700.

The manufacturing centers in the Prairie Provinces have developed at points which are most advantageously served by railroads, while at the same time well situated to serve the export market. Winnipeg, in the southeastern corner of the Prairie Provinces, possesses many advantages for the growth of manufacturing (102). It has been for more than half a century the focus for the economic life of the prairie region. Found in the first area that was settled, it has a long history of industrial growth. Few cities have a more strategic location for the assemblage of raw materials from a vast agricultural area, or for supplying needed manufactured products to that area. Winnipeg's gateway position has made it the leading transportation center. Besides an early start and an advantageous location, manufacturing in the Winnipeg District has been facilitated by municipally operated hydroelectric plants on the Winnipeg River 80 miles to the east. Water supplies are also obtained from a distance through an aqueduct from Shoal Lake on the Ontario boundary. This area also possesses the largest industrial skilled labor force in the region. Winnipeg has evolved into a major industrial city, with about six-sevenths of all industrial development in Manitoba, and about one-third of the regional total. It is noted not only for the processing of agricultural products but also for the manufacture and repair of rolling stock, breweries and bakeries, and for its apparel industries. Other centers processing agricultural raw materials include Calgary, Edmonton, Regina, Lethbridge, Saskatoon, Medicine Hat, and Prince Albert.

In recent years a number of other industries have been growing and the industrial structure of the Prairie Provinces is changing gradually. Of these newer industries none is of greater importance than petroleum. Oil was initially discovered in Turner Valley, Alberta in 1914, and although a number of other discoveries were made in subsequent years, the industry remained small until after 1947, when the Leduc, Lloydminster, Redwater, and other fields were discovered in Alberta and Saskatchewan. The production of petroleum has risen from 12,280,000 barrels in 1948 to over 185 million in 1960. Oil refineries are now located in Edmonton, Calgary, Lloydminster, Regina,

Moose Jaw, and Winnipeg. This area has now become a major exporter of refined petroleum products. The production of oil field equipment has also experienced rapid increases. Besides the petroleum refining industry, the availability of petroleum as a raw material has created a significant petrochemical industry. A wide variety of petrochemical products are produced, including rayon and plastics. Other types of chemicals are now produced in the region, including fertilizers and the manufacture of such inorganic products as caustic soda and chlorine.

As the economy of the Prairie Provinces has spread northward, the exploitation of the forests has become increasingly important. In recent years the forests of this area have produced about 10 per cent of Canada's total output. Wood products are the third largest type of manufacturing in Alberta and Saskatchewan. In these two provinces sawmill products make up the bulk of production. In Manitoba pulp and paper is of greater importance than sawmill products. A single pulp and paper plant is located at Pine Falls on the Winnipeg River. Railway ties, telephone poles, fence posts and pulpwood are produced in each of the three provinces. The lumbering industry is widely decentralized with hundreds of small operations and a few large ones. The Pas in Manitoba has long been one of the chief sawmill centers. The sawmills of this town are located at the point where they can receive the logs by cheap water transportation from the Carrot, Torch, and Saskatchewan river basins and ship the finished lumber to market by railroad transportation. Part of the lumber goes northward to the port of Churchill for export. The sawmills of Calgary receive lumber from the Rocky Mountains by the Kananaskis and Bow rivers. Other important mills are located in the vicinity of Edson on the North Saskatchewan River and near White Court on the Athabaska River. In recent years mills have not necessarily located on rivers, since the logs can now be brought to them by trucks.

On the southern edge of the Canadian Shield, major metallic mineral deposits have been discovered at Flin Flon, Snow Lake, Lynn Lake, and other places. Active exploitation of the metallic mineral wealth of the region began in 1928 when the first railroad was built into the region. The first major ore deposit to be worked was at Flin Flon. To initiate this development a smelter was needed to process the low-metal-content copper-zinc ores at the mine. This mammoth smelter now processes not only local ores but base metal ores from other districts. At Lynn Lake a mill concentrates the nickel ore before it is shipped to a smelter at Fort Saskatchewan, Alberta, where nickel production is being maintained at the rate of 20 million pounds per year. As major new mining areas are exploited, the processing of ores in this region grows in importance. The newest smelter is in the Mystery-Moak District, and was built to process the major nickel deposits of the area.

Pacific Coast. Manufacturing in western Canada is based primarily on timber, fish, agriculture, and water-power resources. The leading industries are sawmilling, pulp and paper, fish curing and packing, and fruit and vegetable processing. Factory production characteristic of the Ontario-St. Lawrence Lowland, such as the production of automobiles, textiles and machinery, has for the most part not developed in this region. Western manufacturers cannot compete in the eastern Canadian market, except in products peculiar to the West, because of high transportation costs. The limited market has hindered the growth of branch plants (97). Most consumer goods, except perishables, are imported from eastern Canada.

The Vancouver District, including Victoria, is the leading manufacturing center. It is the heart of the lumbering and pulp and paper industry. The largest sawmills are found in and near the city of Vancouver. This concentration has resulted from the great size of the mills, the ease of moving the great logs to them by water transportation, and the substantial capital investment needed for their establishment. Furthermore, because nearly all the lumber is exported, marketing from the point where major rail and ship facilities are available is easier. It is also less difficult to secure the necessarily large labor force at a permanent location. Consequently, instead of periodically moving the great sawmills into the forests, the companies bring the logs to Vancouver.

In the past, much of the timber was exported, either as logs or as raw lumber; but now timber is more and more processed and manufactured before it leaves the region. Following sawmilling, the pulp and paper industry is second in importance. This industry is also centered in the Vancouver District. Although all mills must be accessible to their raw material, they are also normally situated to take advantage of cheap hydroelectric power and export transportation facilities. Of the paper produced, over 80 per cent is newsprint, which is nearly all exported. Other forest industries include the making of shingles, plywood, cellulose products, and furniture.

Vancouver, the major Pacific gateway to Canada, has developed manufacturing which reflects its international outlook. The large, well-protected harbors are fringed by factories processing imported goods such as silk, rubber, sugar, and many others. Industrial growth has been particularly rapid since World War II, resulting in an influx of population from eastern Canada and the United States.

On the Pacific Coast the curing and processing of fish is of major importance. Since the fisheries of British Columbia are remote from large consuming centers, the catch must be put in a relatively imperishable state as soon as possible after leaving the water. Consequently, canneries are strung along the coast near the fishing grounds. During the fishing season the cannery towns swarm with people gathered from the entire Pacific Coast. Most of the processed fish is shipped to Vancouver or Prince Rupert for distribution to world markets.

The immense hydroelectric power resources of the Pacific Coast are in an initial stage of development. A combination of rugged topography and abundant precipitation has created a great water-power potential, but extreme distances to populated centers, and, particularly, to well-developed industrial districts, have retarded growth. At present most of the hydroelectric development is near Vancouver. However, with growing demands from industry for additional power, the isolated regions of the coast are being investigated. In 1952 one of the world's largest power developments was begun at the primitive Indian village of Kitimat, about 50 miles south of Prince Rupert. At this power site a new aluminum-producing center has been created. This is the first of many such centers that may be developed by industries seeking low-cost hydroelectric power.

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CHAPTER THREE

EUROPE

Europe for more than two centuries has been one of the major world manufacturing areas. Although an advanced industrial economy has developed in certain areas, others are in an initial stage of development. Industrial output per capita is about $800 in northwestern Europe, Switzerland and West Germany, $640 in western Europe and Italy, $400 in eastern Europe, and $320 in southern and southwestern Europe.

Industrial Trends

In the industrial economy of Europe, three major periods can be distinguished since 1880. The first period from 1880 to 1913 was one of rising industrial production. The recessions were minor and limited to a small time span. During this era the average annual rate of growth was about 5 per cent. Only the United States was growing at a more rapid rate. Nevertheless, on the eve of World War I, Europe's total industrial production was still greater than that of the United States, and Europe accounted for the greater share of world trade and investment.

In the period from 1913 to 1948 Europe suffered two World Wars and a major economic depression. Only during the 1920's did Europe's economy experience significant growth. Unfortunately, much of this growth was lost during the economic depression of the 1930's. The devastation of World War II reduced the European economy to an extremely low level. Between 1913 and 1948 Europe increased total industrial production by only a third, and industrial production per capita rose by only 5 per cent.

The present period of rapid industrial growth, which began in 1949, has been one of the major events of the twentieth century. Although minor recessions have occurred in the 1950's and are likely to occur in the future, the developments are considerably more significant than a mere recovery from a war effort. A major new industrial trend has been established in Europe. After more than a generation of stagnation, the European economy is nar-

rowing with great rapidity the gap between its productivity and living standards and those of the United States. In 1948 West Europe's industrial output was about 50 per cent of that of the United States. By 1960 West Europe's industrial production was about 85 per cent of that of the United States. The total industrial output of West Europe, using 1953 as the base year, has risen from 86 in 1950 to 155 in 1960, a growth of about 70 per cent in the ten-year period. In contrast, the industrial growth of the United States rose from 82 to 119, or an increase of 37 per cent. In certain major industries, Europe's growth has far exceeded the United States. For example, West Europe's output of steel from 1950 to 1960 rose from 57 million to 118 million tons, a growth of 107 per cent. During the same period output of steel in the United States rose from 97 million to 99 million tons, a rise of but 2 per cent.

There are a number of factors which are important in explaining these growth patterns. A remarkable feature of Europe's expansion is the high rate of its industrial investment. With industrial output per capita only 50 per cent of that of the United States, West Europe's annual industrial capital investment is approximately equal to that of the United States. Industrial investment will be the chief means of increasing productivity in the future. Europe has increased its industrial investment at a faster rate than its consumption. Between 1956 and 1960, while Europe's per capita consumption rose about 20 per cent, its industrial investment rose 50 per cent.

Another key to prosperity is Europe's rising industrial productivity. Because industrial labor is scarce in many European countries there is an urgent need for the highest industrial efficiency. Since 1950 European productivity has risen at a rate of 4 per cent annually

There has not only been a rise in the productivity of labor but the industrial labor force has been augmented at the rate of about 500,000 workers per year. The increased number of workers has come largely from the rural farm population. Italy presents a notable example of migration, with workers moving from the rural south to the northern industrial areas. The labor force of West Germany has been greatly increased by the migration of workers from East Germany and the recruiting of workers from Spain, Italy, and other parts of the world (66). In numerous instances private industries decided to migrate from East Germany bringing with them their total labor force including engineers, foremen, and business personnel.

Governmental influence in expanding the economy of postwar Europe has been significant. In the early postwar years foreign aid from the United States, such as Marshall Plan and E.C.A. funds, was instrumental in revitalizing the war ravaged economy. From 1945 to 1957 United States aid totaled over $50 billion.

The West European governments have aided industrial growth in numerous ways. In most European nations the government is more actively engaged in industry than in the United States. In France, for instance, the government owns the coal, gas, electric, and railway industries. It also has interests in oil refineries, motor vehicles, and aircraft and arms plants. In most West European countries government officials, frequently in cooperation with industry, have drafted plans to realize long range production goals. One of the noteworthy developments of this type is the Monnet Plan of France. Established in 1947, it has specific goals to channel industrial investments into six key industries—coal, iron and steel, cement, agricultural machinery, electrical power, and transportation—which are considered basic to general industrial growth. The French government thus is in a position to establish investment patterns for industry. Other types of government aid include low interest government loans, tax inducements to promote private investment, and preferential rates for electricity, gas, and water. It is common practice in Europe for governments to invest more money in nationalized and private industry than is collected in industrial taxes. The outlays are usually made outside the regular budgets and are financed by long-term borrowing. These investments, amounting to as much as 10 per cent of the total investments in some western European countries, act as a support for industrial confidence.

In Eastern Europe all industry is controlled directly by governmental planning. Each

country initiated its own plan, but each has gradually been coordinated with developments in the Soviet Union. The basic objective of these plans is to increase industrial production along specified lines. In all countries, investments in capital goods industries are emphasized. For example, in Czechoslovakia the engineering industries have grown in recent years at an annual rate of 15 or 16 per cent, but food processing has increased only 5 to 7 per cent annually.

The rise of West European trade is another noteworthy incentive to industrial expansion. In the period 1950 to 1960 West Europe's annual trade rose from $20 to $50 billion, or an increase of 150 per cent. The trade of eastern European countries has also risen primarily due to trade agreements with the Soviet Union. Significantly West Europe's importance in world trade is now greater than in the pre-World War I period of free convertibility and the gold standard. International trade has been encouraged in a number of ways. For example, West German industry has sought to manufacture products to the exact specifications of buyers in other countries. Quality products have also been provided, coupled with rapid delivery and adequate credit. The result is that about half of West Germany's exports consist of capital and durable consumer goods.

A noteworthy trend has been the expansion of inter-European trade, particularly in Western Europe. This has been encouraged by the development of such organizations as the European Coal and Steel Community, The European Atomic Energy Community (Euratom), the Common Market and the European Free Trade Association. The European Coal and Steel Community, composed of Belgium, France, the German Federal Republic, Italy, Luxembourg, and the Netherlands came into existence in 1951. Its basic purpose was to provide a free exchange of coal, iron ore, iron and steel, and scrap among the participating countries. These same countries established Euratom in 1959 to provide a common market for nuclear products, and the Common Market, to be implemented in from 10 to 13 years, began in 1959 to provide the free flow of all goods, services and capital among the six nations. The European Free Trade Association, developed in 1960, includes the seven nations of Austria, Denmark, Norway, Portugal, Sweden, Switzerland, and the United Kingdom. The purpose of this group is basically the same as for the Common Market countries, in that it promotes the removal of trade barriers and the expansion of trade among the participating nations. In 1961 the United Kingdom applied for membership in the Common Market.

With the removal of trade barriers the flow of industrial goods has risen considerably. Industries that once produced for a market of 50 million or fewer customers now have a market potential of 170 million persons. This development has a twofold effect. It widens the market for goods and at the same time increases competition. No longer can goods be kept out of a member country by high tariffs or trade quotas. The development forced European manufacturers to install modern equipment, increase efficiency, and reduce costs in order to maintain a competitive position. This process started in 1951 and will continue at an accelerated pace as Common Market policies are implemented. Trade appears to be developing on a sound economic base. For example, for the food products that Italy sells to West Germany, scooters and automobiles are returned that have been made by German machines partly manufactured from French steel.

A number of other factors are influencing the significant industrial growth. Stable price levels in Europe have been fairly well maintained. The wider uses of sales taxes and other levies on consumption have the effect of reducing demand for consumer goods. This policy releases funds for investment and expansion. As a result price rises have been smaller in Belgium, Germany, Italy, the Netherlands, Denmark, and Switzerland than in the United States. Another basic reason for Europe's growth is the relatively low wage scale of the average factory worker. In January 1961 the average hourly pay and fringe benefits totaled $1.15 in Sweden, 86 cents in West Germany, 80 cents in Switzerland, 77 cents in Belgium and France, and 63 cents in Italy and the Netherlands. These wages compare with $2.77 in the United States. As a consequence the European countries are

able to market their products competitively throughout the world.

Recent Trends of Selected Major Industries

Textile industries. The European textile industry has long occupied a prominent place, not only in the economic activity of Europe, but also in the world textile industry. Although the position of the European textile industry declined during the 1930's, it is estimated that in 1938 this industry employed 3.6 million workers and produced 35 per cent of the world's textiles. The Second World War had an adverse effect on the industry in partially dispersing its labor force, by preventing the replacement of worn out equipment, securing necessary raw materials, and cutting off markets which in the postwar period have been difficult to regain because of newly developed competition.

At the conclusion of World War II the rehabilitation of the textile industry was necessary because of the size of the labor force it employed, the basic human requirements which it provided for, its economic significance and the volume of its international trade. As a result between 1946 and 1953, the smaller countries such as Ireland, Norway, Sweden, Finland, Denmark, the Netherlands, Poland, Hungary, and Greece increased their textile production by 50 per cent or more. However, production in the major producing countries such as the United Kingdom, France, and Italy experienced a much smaller expansion. As a result there has been a greater change in the pattern of postwar textile production than in any of the other major industries of Europe.

With the recovery of the textile industry a number of significant trends became apparent. Of these trends the general displacement of cotton and wool by synthetic fibers is noteworthy. The increase in cotton yarn in 1960 was only 5 per cent over 1951, compared with a 17 per cent increase in rayon and acetate filament yarn. Significant advances have been made in rayon production in the United Kingdom, France, Belgium, West and East Germany, the Netherlands, Norway, Sweden, Czechoslovakia, Austria, and Switzerland. Emphasis has been placed on synthetic fibers because of available raw materials and the demand for these types of cloth.

Another significant trend continuing from the pre-World War II period has been the decline in textile employment. The number of workers has decreased from about three million in 1950 to just over two million in 1960. In contrast, production of cotton yarn rose from 1,950,000 tons in 1951 to 2,047,000 in 1959, and rayon and acetate filament yarn increased from 368,700 tons to 431,500. This illustrates the rising efficiency in the industry caused by the introduction of modern machinery.

As a result of the early recovery programs, textiles were the first to be in excess supply in postwar Europe. By the early 1950's sales had declined to a low level, both domestically and in foreign trade, as stocks increased in nearly every country. The over-capacity of textile production has been most acute in the new, smaller producing countries and the United Kingdom. In nearly all of these countries, textile production is based predominately on sales to the home market. For several years after the war the expanded output was easily absorbed domestically. However, by the early 1950's the pent up demand was largely satisfied, and the bigger countries, notably West Germany, France and Italy, had gained a greater share of the export market, causing the demand for textile production in most of the smaller countries to decline greatly. As a response, textile production has grown slowly in most countries in recent years.

Engineering industries. The engineering industries have experienced remarkable growth in recent years. Because of great destruction and inability to replace worn out machinery during the war years, there was an immediate demand in the early postwar years for products of the engineering industries. Germany and Italy were the only nations where these industries lagged greatly during the early postwar recovery. By 1948, with the exception of Germany, the engineering industries of Europe were some 30 per cent above their prewar level of production. However, West Germany's industry rose rapidly after 1949 and by 1951 was approximately one-fifth larger than in 1938.

During the 1950's the engineering industries of Europe grew at a more rapid rate than other industries, except chemicals. However, there were great divergencies between countries. The differences in growth are largely explained by three interrelated factors. First, and most important, the growth in engineering industries was directly related to the over-all economic growth of the country and a consequent increase in demand for capital goods and consumer durables. Second, a country's competitive position in the international market affected the rate of expansion of its engineering products; and third, the expansion of imports competing with domestic industry affected the growth of production. On the average, rising exports accounted for one-third of the increase in domestic production of European engineering industries between 1952 and 1960. In Belgium, Italy, the Netherlands, Norway, and the United Kingdom, the ratio of export growth to output growth was about equal to the average European growth. In West Germany the rise in exports accounted for more than half of the rise in output. In Denmark and Sweden the increase in exports was even larger. France was the only country in which the growth of output was almost exclusively based on an expanding domestic market and exports have risen only in recent years (14).

Between 1954 and 1960 output of metal manufacturing and nonelectric machinery increased in Western Europe by approximately 50 per cent, based on value. Output of other types of engineering goods increased by about 75 per cent. Many branches of engineering have shown remarkable growth. One of the spectacular increases in production has been achieved in the motor vehicle industry, with a rise in output from 2,676,000 units in 1954 to 5,433,000 in 1959, or an increase of 103 per cent.

Chemical industries. The growth of the chemical industries of Europe since World War II has been spectacular. At the conclusion of the war—due partly to destruction and partly to dollar shortages to import—there was an alarming deficiency of chemical products and fertilizers in most countries. Simultaneously with the collapse of European production, demand rose above that of the prewar period. In the case of fertilizers, this was the result of the impoverishment of the soil during the war and of the effort made in most countries for increasing agricultural production to cope with the shortage of foodstuffs. In the case of other chemical products, the greater demand came as a result of technical progress, which greatly increased the various methods of application.

The expansion of output of chemical fertilizers is typical of present-day developments in the European chemical industry. An expansion program was initiated in all of the fertilizer industries in order to provide for the demand in the agricultural sector of the economy. The growth of the superphosphate industry was most remarkable. By 1950 Germany and France were the only nations that had not surpassed their prewar production, and total European output of superphosphates had risen to 8,600,000 tons. The upward trend has continued, with output of superphosphates rising to 12,170,000 tons in 1959. Countries experiencing major rises are Spain, with production increasing from 708,000 tons in 1948 to 1,800,000 in 1959, and Italy, with an increase from 1,225,000 to 1,794,000 tons.

The basic chemical industries have also experienced a rapid expansion. For example the output of sulphuric acid rose from 10,328,000 tons in 1951 to 16,262,000 in 1959. Remarkable increases have occurred in a number of countries. West Germany's output rose from 1,703,000 tons in 1951 to 2,938,000 in 1959. Italy's production increased during the same period from 975,000 tons to 2,053,000.

Location of Industry

Initial pattern of localization. Although modern industry originated in Europe, its distribution long remained concentrated in only a few European countries. As late as 1913 the United Kingdom, France, and Germany accounted for more than 70 per cent of Europe's manufacturing capacity. The predominance of these three countries was particularly striking in the output of steel, machinery, and chemicals. They produced about 80 per cent of Europe's output in each of these industries. Their share in the textile industries was also high and in cotton textiles

reached almost 75 per cent of European production.

The concentration of industry in these three nations is primarily explained by the distribution of energy in Europe. The Industrial Revolution was largely a revolution in energy consumption, and coal predominated as the source of energy for mechanical power until after World War I. Of the European nations, the United Kingdom, France, and Germany in 1913 produced 93 per cent of the European coal output. The remainder was largely mined in Belgium, and the Austro-Hungarian Empire. Europe had limited oil resources, and hydroelectric power was little developed at this time.

With the impetus provided by the availability of mechanical power, other factors contributed to the concentration in these three countries. The skills gradually acquired through centuries of industrial application gave these countries a large and highly skilled labor force. From this labor force, inventive genius emerged to continuously provide new machines for furthering the efficiency of industrial output. Gradually these nations developed an excellent system of water, rail, and road routes facilitating the movement of raw materials and finished commodities. These nations also possessed a large, expanding population with a high purchasing power that provided a domestic market.

The industrial structure of Europe in the nineteenth century was also influenced by the area's economic predominance in the world. In the United Kingdom especially, but also in France and Germany, industry was strongly oriented to export markets. It was because of this emphasis that textiles possessed so large a share of industrial employment. Industry commonly depended on foreign markets as a major source of expansion. As late as 1913 about 60 per cent of the world's export of manufactured goods originated in the United Kingdom, Germany, and France.

Outside the major industrial nations, the remaining 30 per cent of European industry in 1913 was widely distributed. Most of the smaller nations specialized in the production of commodities in which they possessed a particular advantage. The Austro-Hungarian Empire alone reflected a miniature edition of the Big Three. However, its industries were not well developed and its aggregate output did not exceed 6 per cent of the European total. Belgian industry was expanding rapidly and formed a major area in the industrial zone extending from the Ruhr to northern France. Italy was still in an early stage of industrial development and concentrated its efforts on textiles. Specialized centers of manufacturing had developed in Switzerland (watches and machinery), Sweden (timber products and steel), and the Netherlands (shipbuilding), among others.

Modern localizational trends. The United Kingdom, Germany, and France remain the major manufacturing nations of Europe. Nevertheless, every country in Europe has attempted to increase its industrial potential in the past 40 years. A number of factors have favored decentralization of industry, but at the same time other factors have been influential in maintaining the traditional centers (15).

World War I had a major effect on the industrial pattern of Europe. During the war years most countries expanded output. Only in the war-devastated areas, such as France, Italy, and Belgium, was industrial output greatly retarded. At the conclusion of hostilities the peace treaties created a new political pattern which changed the older economic system. The Austro-Hungarian Empire was divided into a number of new countries. Germany lost territory on its periphery, and France, Romania, and Yugoslavia gained additional territory.

As a result of the new frontiers, industrial regions were redistributed among the countries. Complementary industries, which had developed as integrated parts of large economic units, had now to be adjusted to new frontiers and national frameworks. A number of the new countries, such as Hungary and Yugoslavia, found themselves without essential industries, and in other countries, such as Austria, the existing industries were too large for the restricted domestic market.

World War II also influenced the political pattern of Europe, although not as profoundly as World War I. There were fewer boundary changes in Europe after World War II. The most significant ones affected Poland and

Germany, with Poland securing the rich Upper Silesian Industrial Area, and Germany being divided into East and West. As a result of the war devastation and the restrictions imposed on the defeated nations, particularly Germany, it appeared for a short time that a new distributional pattern of production could develop in Europe. This was because of the significant rise of production in many of the smaller nations and the industrial decline of the defeated nations. However, after 1948 the defeated nations recovered their industrial output rapidly and by 1951 had surpassed their prewar production.

A number of other factors have influenced the growth of industry in particular countries. Of considerable importance has been the varying population trends in the European countries. Prior to World War I the United Kingdom, Germany, and France experienced rapid population growth. In contrast, since 1920 a number of other European countries grew more rapidly. Until the 1920's the problems of excess population were primarily solved by mass migration, largely to the United States. With the passage of restrictive U. S. immigration laws this migration declined. As a consequence, many of the European countries, particularly in the east and south, were faced with serious unemployment problems. In most countries the rural areas were already overpopulated. Under the triple pressure of rising population, restricted migration, and overpopulated rural areas, the problems of economic survival were aggravated. Many nations have turned to industrialization in order to alleviate population pressure and raise standards of living.

Changes in technology have also encouraged the development of manufacturing in the less industrialized areas of Europe. In many branches of industry, industrial techniques can easily be transplanted from one country to another. The new developments in the field of power make it possible to transport electrical energy cheaply for several hundred miles, thus releasing industry from its orientation to coal sources. At the same time new mass production techniques in a number of fields increased the scale of industrial output, and even with increased consumption domestically, the small and medium-sized countries provided a market that was too small to absorb the output of modern mass production methods. Consequently, certain industries, such as motor vehicle production, have continued to be concentrated in the larger nations.

The type of governmental influence has changed from time to time, but governments continue to play a significant role in the development of industry. Prior to 1940 state intervention was frequently related to the growth of economic nationalism. This was particularly apparent in Germany and Italy, where one of the major goals was to strengthen the war potential through national self-sufficiency. From the middle 1930's onward the preparations for World War II influenced the development of European industry. Germany and Italy greatly expanded industries that possessed a direct war potential. In contrast France and the United Kingdom were relatively little affected by this trend. The disparity in rate of growth between various countries was a major characteristic of the 1930's (14).

The tariff policies of the European nations have also influenced industrial location. Since 1920 they can basically be divided into two periods: high tariffs before World War II, and the gradual removal of tariff barriers since World War II. The high tariff walls and other restrictions encouraged the development of national self-sufficiency. As a consequence manufacturing was not only developed in each nation, but it became more diversified. In numerous instances industries developed which could survive only under government protection. In contrast, the postwar period emphasis on national self-sufficiency has been diminished with the development of the European Coal and Steel Community, the Common Market and other intra-European organizations. With the removal of tariff restrictions, each country is tending to emphasize those industries in which it has the greatest competitive advantage. The growth of a particular industry depends to a considerable degree on the size of the European market rather than the size of an individual country.

It must not be thought, however, that governmental influence in the establishment of industry within a particular nation has dis-



3.1. Manufacturing Regions in Europe.

appeared. All European governments are aware of the need for a strong industrial economy. The governmental influence on locating industry will vary from aid given to private industry through tax reductions, subsidies, and the like to complete state control of the location of industry, as exemplified by the communist dominated countries of Eastern Europe.

There are in Europe about 40 million factory workers in manufacturing, of which 32 million are in Western Europe and 8 million in the Eastern part.[1] The United Kingdom (8 million), West Germany (7,550,000) and France (5 million) possess about half of the total. If Italy with its 3,500,000 workers is added to the three major manufacturing nations, these four together possess about 60 per cent of the manufactural employment in Europe. In Eastern Europe, East Germany, Poland, and Czechoslovakia dominate manufacturing.

[1] About 20 million additional workers are engaged in handicraft industries.

UNITED KINGDOM

The United Kingdom was the first nation to be affected by the Industrial Revolution. Today, it remains one of the major industrial

nations of the world. Of the gross national products, manufacturing supplies about 38 per cent of the total. British industry is based primarily on imported raw materials and the maintenance of a major export trade.

Industrial Structure

The manufacturing industries of the United Kingdom produce an exceedingly wide range of products. In terms of output, the metals and associated engineering industries—including transportation—provide nearly 50 per cent of British industrial production. The textile and apparel industries produce about 12 per cent of the total and chemicals 10 per cent. Other industries of importance include food processing, ceramics, leather, and paper and printing.

Metals manufacturing. The metals industries employ nearly 600,000 persons, of which nearly three-quarters are engaged in the iron and steel industry. This industry is one of the oldest in Britain. British inventions laid the foundation for the great expansion of steelmaking in the latter part of the nineteenth century. In recent years the British iron and steel industry has undergone a period of rapid expansion. Since 1946 output of steel has risen from 12,700,000 to 20,200,000 tons in 1959. The industry has a capacity to produce 25,500,000 tons of steel annually. During the same period output of pig iron rose from 7,800,000 to 12,600,000 tons. In 1959 the direct export of steel totaled 3,700,000 tons and indirect export, in the form of steel consuming industries, an additional 4,100,000 tons.

South Wales and the Northeast Coast of England are the largest iron and steel producing districts. In 1959 these areas produced 8,400,000 tons, or nearly 40 per cent of the national total. Scotland with an output of over two million tons is the major supplier of metal for the engineering industries of the Clyde estuary. Other areas of steel production include the Midlands, Eastern Pennine, Lincolnshire, and Lancashire.

Since World War II British industry has not only been expanded in size but has been modernized. The country now possesses some of the most modern plants in Europe. It is estimated that by 1962 over £1,000,000,000 will have been spent on development and modernization since 1945.

A branch of the basic iron and steel industry is the production of iron castings. At present there are 1,500 firms, employing 128,000 people. Iron foundries are widely distributed in Britain, but the major concentrations are in the Midlands and other engineering centers. Annual output varies from three million to 3,500,000 tons. Of this amount, about one million tons are consumed by the engineering industries, 700,000 tons by the motor vehicle industry, and 400,000 tons by the steel industry.

The nonferrous metals industry of Britain, which employs about 128,000 workers, is the largest in Europe. Within the country the smelters and refineries are located within market areas or are situated on the coast in order to process the metals as they enter the country. Nearly half of the industry is located in the Midlands. Other important centers include South Wales, London, Tyneside, and Avonmouth. Production in 1960 included 25,000 tons of aluminum, 96,000 tons of copper, 97,000 tons of secondary metals, 89,000 tons of lead, 73,000 tons of zinc and 28,000 tons of tin.

Engineering industries. The engineering industries are the major branches of manufacturing in Britain. The industry is composed of two principal branches. Of these the mechanical engineering industries are the largest, with 1,200,000 workers. The electrical engineering industries have a labor force of about 770,000.

Mechanical engineering. Many of the mechanical engineering industries date from the early stages of the Industrial Revolution. Of these, textile machinery is one of the oldest dating from the end of the eighteenth century when mechanical spinning and weaving were introduced. The industry now employs 53,000 people in 450 firms. These firms are primarily located in the textile regions of Lancashire and Yorkshire, and the cities of Nottingham, Leicester, Dundee, and Belfast. Although the export of textiles has declined greatly in the twentieth century, the export of textile machinery has increased. In 1959 when £71,000,000 worth of textile machinery were produced, £41,000,000 worth were exported. India, the

Soviet Union, Australia, and West Germany were the major markets.

The machine tool industry was also one of the early mechanical industries of Britain. The modern machine tool industry had its origin in the United Kingdom and by the 1830's had reached an advanced state. Today the industry employs about 42,000 workers in 300 firms. The industry is centered near its market in the Midlands, Yorkshire and Lancashire, and to a lesser extent in London and Glasgow. As in most countries the machine tool industry of Britain has experienced wide fluctuations in production with the value of output varying from £6,500,000 in 1935 to over £95,000,000 in 1957.

The agricultural machinery industry has become increasingly important and now employs about 37,000 persons, of which one-half produce tractors. In 1959 the United Kingdom produced 216,000 tractors, of which 116,000 were exported. In that year Britain exported more tractors than the total for the rest of the world. The largest markets for tractors are the Scandinavian countries, Anglo-America, Australia, and South Africa. With increased mechanization of British agriculture the domestic market has expanded. For example, in 1959, 4,400 combine harvesters and 23,800 mouldboard plows were produced. The production of agricultural machinery is dispersed, but the greatest concentrations occur in the agricultural areas of East Anglia and Lincolnshire.

Scientific and industrial instruments have been produced for over 200 years. The early products were primarily navigational and optical equipment. However, as demands for mechanical products have changed, there have been some notable changes in this industry in recent years. One of the most rapidly growing branches is that of office machinery in the output of such items as electronic computers, typewriters, dictating machines, and duplicators. The growth of this industry is strongly based on an export market. In 1959, of an output valued at £60,000,000, over £23,000,000 worth were exported.

A wide range of other mechanical items are produced. The refrigeration equipment industry was established prior to World War II but has become important only in recent years. For example, the output of domestic refrigerators increased from 360,000 in 1957 to 934,000 in 1959. The trend in construction equipment is also noteworthy. Before World War II small road building equipment dominated the industry. Now, heavy, motorized earth-moving equipment is of importance. About 24,000 persons are at present employed in this industry. Other mechanical products include industrial engines, boilers, foundry and steelmaking equipment, nuclear power station equipment, and petroleum and chemical plant equipment.

Electrical engineering. The electrical engineering industries have grown rapidly in recent times, with products ranging from household items to nuclear control instruments. The value of output increased from £155,000,000 in 1938 to £1,400,000,000 in 1959. Within the industry, 213,000 workers are engaged in the manufacture of electrical machinery and about 230,000 in the production of radios, television sets, and other electronic equipment. Normally more than 15 per cent of the electrical machinery produced is exported.

A number of the branches of the industry are of importance. The British have made basic contributions to the generation and transmission of electric power. This industry is widely distributed with major concentrations at Manchester, Tyneside, and Stafford. In 1959 more than 1,200,000 kilowatts of steam turbine plants of 10,000 kilowatts or more were exported.

The production of electronic equipment is one of the most rapidly growing branches of the industry. The volume of output is estimated to have increased 50 per cent between 1954 and 1959. The consumer goods industries now produce a wide range of electrical appliances. In 1959, 1,230,000 washing machines, 2,484,000 electric irons, 474,000 electric cookers, and 1,651,000 vacuum sweepers were produced.

Transportation equipment. The transportation equipment industries are among the largest in Britain. In 1960 employment totaled about 1,200,000, of which 420,000 were engaged in the manufacture of motor vehicles and cycles, nearly 300,000 in shipbuilding and marine engineering, 280,000 in the manufac-

ture and repair of aircraft, and 145,000 in the manufacture and repair of locomotives, passenger and freight cars. In addition 300,000 persons are employed in garages.

The motor vehicle industry has expanded rapidly with output in 1959 reaching 1,190,000 passenger cars, 353,000 commercial vehicles, and 17,400 buses. Since World War II the export trade has been important to the welfare of this industry. In 1959, 569,000 passenger cars and 123,000 commercial vehicles were exported. The industry is located primarily in the Midlands, Oxford, and London areas, oriented partly to the engineering industries and partly to its market. Although there are many producers, five companies—British Motor Corporation, Ford, Rootes, Standard and Vauxhall—dominate production.

A shipbuilding industry has been found in Britain for centuries. In the late nineteenth century and until World War II, British shipyards dominated world production. Since then British shipbuilding has declined relatively in importance due to rise of foreign competition. Nevertheless the industry remains vigorous. Between 1945 and 1959 British shipyards launched over 18 million gross tons of shipping, including four million gross tons for export. In order to modernize and mechanize the shipyards, over £70,000,000 were invested between 1946 and 1962. The industry is centered in four areas: (1) on the Clyde estuary of Scotland, (2) the Northeast Coast along the lower reaches of the rivers Tyne, Wear, and Tees, as well as at West Hartlepool and Blyth, (3) on the Northwest Coast of England along the Mersey River and at Barrow-in-Furness, and (4) at Belfast in Northern Ireland. Small craft are also built at many places in Britain.

The aircraft industry is strongly influenced by military needs. As a result employment has fluctuated greatly from a low of 35,000 in the 1930's to over two million during World War II. Since World War II, employment has varied from 162,000 to 315,000. The industry is located in London and the Home Counties, Derby, Coventry, and Bristol, as well as in the Scottish Lowlands. The aircraft industry also has a significant export trade.

Equipment for the railroads is built partly by private firms and partly in the British Railway shops, which are nationalized. About 70,000 workers are engaged in making locomotives and railway equipment. As a result of the modernization program, British railways by 1959 had received 420 main-line diesels and 85 electric locomotives, and had on order 800 and 110 respectively. The export trade is also significant. In 1959, 1,294 diesel locomotives, 145 electric locomotives, 230 passenger coaches, and nearly 5,000 freight cars were exported.

Chemical industries. The modern chemical industries of the United Kingdom developed in conjunction with the textile industry. The need for bleaching powders to prepare cloth was fundamental to finishing textiles. Gradually, the industry became increasingly complex, producing acids, alkalis, alcohols, explosives, fertilizers, dyestuffs, soaps, paints, pharmaceuticals, and a host of other products. The industry now employs about 450,000 persons. Expansion in recent years has been rapid, with the number of employees rising by more than 20 per cent between 1948 and 1960.

Heavy chemicals provide the base for British chemical industries. Many of these are fundamental to the chemical industries of other nations. Output of basic chemicals has risen greatly. For example, the production of sulphuric acid in 1959—2,400,000 tons—was about two and a half times the prewar figure.

The petroleum refining industry has undergone a major expansion since 1945. In 1947, only about 17,500,000 barrels of oil were refined in the United Kingdom. By 1953 the total reached 185,500,000 barrels, and in 1960 the total was over 300 million barrels. The rise of the industry is due to a number of factors, of which the growth of the motor vehicle industry is most significant; but the use of petroleum for industrial and domestic heating is also of importance. The industry is localized on the coast to process the imported oils. The major center is the London area, with refineries at Shell Haven, Coryton, Isle of Grain, and Kingsnorth. Other important centers are at Holyhead, Fawley, Llandarcy in South Wales; Stanlow and Heysham in northwest England; Grangemouth and Ardrossan, Scotland; and Belfast in North Ireland. The petrochemicals are increasingly outstanding. The petroleum chemical industry provides raw materials for solvents, plastics, detergents, synthetic rubber, and many other products.

The petrochemical industry is oriented to the oil refineries at Fawley near Southampton, Stanlow in Cheshire, Grangemouth in Scotland, Wilton in Yorkshire, and Severnside near Bristol. The growth of this industry is well-illustrated by plastics. Although the first plastic, celluloid, was produced in Britain in 1865, the industry did not become important until after World War II. Between 1948 and 1959 the output of plastics increased fourfold to a total of 500,000 tons. Thermoplastic materials such as polyethylenes accounted for 308,000 tons of the total in 1959, a rise of two and a half times over the 1954 level. In 1959, 107,000 tons of plastics were exported.

A number of other chemicals are important. The fertilizer industry, aided by government subsidy, has expanded. Output of nitrogenous fertilizers in 1959 totaled 350,000 tons, three times the prewar volume, and 371,000 tons of superphosphates were produced, twice the prewar figure. The paint industry is well developed, with about 46,000 employees. Production has grown rapidly from 69 million gallons in 1953 to 90 million gallons in 1959. Other important chemicals are pharmaceuticals, pesticides, and weedkillers.

Textile and apparel industries. The United Kingdom was the first nation to develop a modern, mechanized textile industry. It remains a major activity with a labor force of one million people, including about 250,000 in the spinning and weaving of synthetic fibers and cotton, 205,000 in the wool textile industry, 185,000 in textile finishing and associated industries, and 120,000 in hosiery and knitted goods. There are also about 470,000 workers in the apparel industry.

Of the textile industries, cotton occupies a prominent position. For nearly 150 years the United Kingdom dominated the cotton textile production of the world. However, during much of the twentieth century the cotton textile industry of Britain has been in a chronic state of depression. The early British industry was based primarily on an export market and, with the rise of foreign competition and the growth of the cotton textile industry in most other countries of the world, the British industry has been adversely affected. It has experienced a continuous downward trend since 1913, and it is still declining. Between 1937 and 1959 the labor force declined 50 per cent, so that only 100,000 workers remain in spinning and 93,000 in weaving. The output of cotton cloth in 1959 was about one-half that of 1937, and consumption of raw cotton totaled 284,000 tons, in contrast to 639,000 tons in 1937. Exports had declined even more drastically. In 1959 legislation was passed to reorganize the industry. In order to reduce capacity the government has obligated itself to pay two-thirds of the cost for the removal of antiquated equipment, and one-fourth of the cost for modernization and re-equipping. Nevertheless, the future of the cotton textile industry is uncertain.

The woolen and worsted industry of the United Kingdom is the largest in the world, and has been an important source of income since the medieval period. About 85 per cent of the woolens and 95 per cent of the worsteds are produced in the West Riding of Yorkshire. In contrast to the cotton textile industry the woolen and worsted industries have remained prosperous. Foreign competition has only been moderate and the export trade remains a leading source of income. The United Kingdom's annual consumption of clean virgin wool is about 500 million pounds, equivalent to one-fifth the total world consumption (excluding Eastern Europe and China).

The synthetic fibers have become increasingly important in the British textile industry. Much of the early development of synthetic fibers occurred in Britain. Production is more widely distributed than for that of cotton or woolen textiles, with major concentrations in the Midlands, Yorkshire, and Lancashire. The growth of the nylon industry typifies trends in synthetic fibers. The production of nylon started in 1941 for military uses. Since World War II plants have been built at Pontypool in South Wales, Doncaster in Yorkshire, and at Brockworth near Gloucester. The annual capacity for nylon production is 60 million pounds.

The hosiery and knit goods industry is widely distributed throughout the United Kingdom, with major centers in the Midlands and Scotland. Because the industry produces primarily for a domestic market, it has only been moderately affected by foreign competition. About 80 per cent of the firms employ

fewer than 50 people. Annual output is about 80,000 tons, of which one-half is woolen yarns; but synthetic fibers are increasing in importance. The linen industry, based largely on imported Belgian flax, is important in Northern Ireland. Carpet manufacture employs about 30,000 workers, with principal centers at Kidderminster in Worcestershire, Halifax, and Dewsbury in West Riding of Yorkshire, and Durham, Glasgow, and Kilmarnock in Scotland.

The apparel industry of Britain is the largest in Europe. As in the textile industry, about three-quarters of the employees are women. The industry is oriented to the larger markets, particularly London, and also to the textile centers. In recent years gross annual output has been valued at £500,000,000.

Nonmetallic industries. The United Kingdom has well-developed nonmetallic industries. Possibly the oldest industry in Britain is brickmaking. It was introduced by the Romans and has persisted in an advanced state for well over 2,000 years. At present there are 800 firms producing over 2,000 types of bricks. The industry is widely dispersed, but about two-fifths of the production consists of the Flelton-type brick, produced mainly in the Peterborough and Bedfordshire areas. As a response to the high level of construction in Britain, output of bricks has increased. In 1960 output totaled 7 billion.

Of the British nonmetallic industries, ceramics have gained international renown. Ceramic products date from the Roman period. They are based on domestic deposits of china clay, ball clay, and china stone from Devon, Cornwall, and Dorset. Reserves will last at least a century. About 85 per cent of the industry is concentrated in the Stoke-on-Trent area of Staffordshire in the six towns of Stoke, Burslem, Tunstall, Hanley, Fenton, and Longton. The industry employs about 35,000 workers, and in 1959 produced £32,000,000 worth of pottery of which £14,000,000 worth were exported.

The British glass industry is the third largest in the world. The 77,000 workers in the industry produce a wide variety of products. A traditional item is handmade lead-crystal glassware of the highest quality. Nevertheless, more common glass products such as plate glass and bottles are of more importance. The export industry has developed rapidly. In 1938 only quality glassware was exported with a small total value. By 1959, £18,500,000 worth of glassware was being exported.

Under the impetus of the vast construction program underway in Britain since World War II, the cement industry has increased rapidly. The output of the industry, which employs about 16,000 people, rose from 7,700,000 tons in 1938 to 12,600,000 tons in 1960. Although much of the production is market oriented, about one-third comes from plants situated in the Dartford-Gravesend district of Kent, where massive limestone deposits occur. In 1959, 1,100,000 tons of cement were exported, primarily to Africa.

Other industries. The food, drink, and tobacco industries of Britain employ about 900,000 persons. Much of their production is for domestic consumption. However, several major exceptions do occur. Scotch whisky, which was distilled as early as the fifteenth century, enjoys world-wide popularity. Whisky is one of the United Kingdom's largest dollar earners. More than half the annual export (which in 1959 attained £61,900,000) comes to the United States. Cocoa, chocolate, and sugar confectioneries, as well as canned foods, are also important export commodities. The tobacco industry employs about 48,000 people and processes almost 300 million pounds of raw tobacco annually.

Leather tanning is one of Britain's oldest industries. This industry is widely dispersed, but there are concentrations in Northampton, Lancashire, Cheshire, Yorkshire, Midlands, and London. The industry employs about 31,000 persons in leather tanning and associated industries and about 24,000 in the leather goods industry. The United Kingdom is the world's largest exporter, but about 50 to 60 per cent of its hides and skins must be imported to supply the industry. The leather industry is much more concentrated than the tanning industry, being market oriented toward the large cities such as London, Bristol, and Birmingham.

The paper and printing industry has long been established in Britain. Output of paper has grown rapidly in recent years from 2 million tons in 1938 to 3,660,000 tons in 1960.

The industry is comprised of 200 mills, producing every type of paper and board, and employing over 90,000 persons. Lancashire and Yorkshire are major centers of paper production. The industry localized here because of pure water from the Pennines, availability of coal and chemicals, and an abundant supply of rags from local textile industries. The North Kent area, including Dartford, Gravesend, and Maidstone, is important for newsprint. The coastal position of North Kent makes possible the import of fuel and raw materials, and London provides a close market. Printing is widely dispersed, with most of the 6,000 firms having fewer than 25 employees. Book publishing is, however, concentrated in London.

The British rubber industry is the oldest in the world, having been established in 1819 when the method of processing rubber was invented. The first pneumatic tire was produced in Britain in 1888. At present, half the total output is tires and tubes. There are some 600 firms, employing about 120,000 people. The industry is located on the coast in order to process imported rubber, but is also found near its market in the Midlands and Lancashire.

Manufacturing Regions

The industrial regions within the United Kingdom reflect the existence of Europe's most productive coal fields. In Great Britain the northernmost industrial district is found on the coal fields of the Scottish Lowlands. In England and Wales, the major coal fields—Northeast Coast, Eastern Pennines, Midlands, Lancashire, and South Wales—are areas of industrial concentration. The only major industrial area of Great Britain not situated on a coal field is the London metropolitan area. This city is strategically situated on the Thames River, facing Europe and the world market. It has developed a highly diversified industrial economy. In Northern Ireland, Belfast has evolved a major manufacturing complex.

Lowlands of Scotland. The manufacturing of Scotland is largely concentrated in the Scottish Lowlands, an area about 50 miles wide extending from Edinburgh on the east to the Clyde estuary on the west (Map 3.2). Three considerations have affected the localization of industry in the lowland. One of these has been the relative isolation of the region from English industrial centers. As a result, an early handicraft industry was established which provided needed goods for the Scottish people. This endeavor created a skilled labor body and a local market for manufactured goods. Second, the lowland route between the Atlantic Ocean and the North Sea facilitated the import of raw materials and the export of finished goods. Finally, the availability of coal attracted the heavy metallurgical industries.

One of the earliest of the modern industries to develop in the Clyde Valley was cotton textile manufacture. The Clyde region possessed the same advantages as Lancashire in its soft



3.2. Manufacturing Regions of Great Britain.

water, high humidity, water power (and later, coal), easy access to trans-Atlantic routes, available labor, machinery, and a local market. However, the textile industry took a secondary position with the growth of the modern iron and steel industry. Because of the availability of some local iron ore and coking coal, capital, organizational ability and skilled labor were rapidly attracted to the metallurgical industries.

Because of the coal and iron ore being located in the western portion of the region, the iron and steel industry was largely concentrated on the coal measures in the late eighteenth and early nineteenth centuries. Blast furnaces and steel mills developed in Glasgow, Audie, Coatbridge, Motherwell, Wishaw, Paisley, and Johnstone. Gradually a "Black Country" developed around Glasgow. Although the local iron ores were soon exhausted and coal mining has declined in recent decades, the area is still an important metallurgical center (23).

With the availability of metal, large engineering plants developed, producing a vast gamut of products such as pipes, locomotives, motorcars, pumps, and machinery. However, the most famous branches of the engineering industries are those connected with shipbuilding and associated marine facilities. These activities are carried on along the banks of the Clyde from Glasgow for about 20 miles downstream. Some of the world's largest liners have been built in the Clyde estuary from Dumbarton to Greenock. In the 1870's this area built half of British naval and merchant tonnage. Since then the importance of the district has declined, and it now produces about one-third of British ships. This decline is because of lessening availability of metal and the rise of newer, more efficient shipbuilding centers in Britain. Other industries in the western Scottish Lowlands include the chemical industries directly associated with the metallurgical output. A specialty textile industry has also evolved. Paisley is noted for its thread, Glasgow for its fine weaving of Lancashire yarn, and the Levan Valley for the finishing of local and Lancashire fabrics.

The eastern portion of the Scottish Lowlands, with such cities as Edinburgh, Dundee, Aberdeen, and Perth, cannot compare in industrial importance to the western portion. Edinburgh specializes in light industries such as printing and publishing, and is possibly the least industrialized of the major British cities. Aberdeen has had a large and varied industrial development. In the seventeenth century, local weavers, plus the skill of immigrant weavers from Flanders, made it a widely renowned woolen cloth center. In the eighteenth century its woolen hosiery was sold throughout Europe. With the introduction of modern weaving during the Industrial Revolution, Aberdeen, lacking coal for power, soon declined as a textile center. It subsequently became famous as a builder of wooden ships; but with the introduction of iron vessels this industry also disappeared. Aberdeen next turned to North Sea fishing, and the making of fishing equipment has persisted to the present day. It also has a paper industry based on pulpwood imported from Scandinavia.

Dundee and Perth are textile centers. In the nineteenth century a jute industry was established based on a thriving trade with India. Later, with the rise of Calcutta as a jute processing center, the declining jute industry was largely replaced by a linen industry based on flax from Ireland and the Baltic countries. Textile mills are found bordering the Firth of Tay. Dundee is also known for its marmalade, produced from Spanish oranges.

Northeast Coast. The major concentrations of industry on the Northeast Coast of England are found in the Tees and Tyne river valleys. The greatest iron and steel industry of Britain once flourished in the Teesmouth area. The rapid rise of the area was due to the availability of iron ore in the Cleveland Hills to the south and coal from the Durham fields to the north. The iron and steel industry was centered in the Tees River valley at a point midway between the raw materials, as well as at a tidewater location facilitating the marketing of the iron and steel. Middlesbrough, Stockton, and Hartlepool are large primary metallurgical centers. The blast furnaces are along the waterfront in sites that are somewhat similar to those of the Gary-South Chicago mills (28).

Prior to World War II the iron and steel industry of the region experienced a declining trend. Three factors were primarily respon-

sible for this change. First, the iron ores of the Cleveland Hills were diminishing in importance, and the area was increasingly dependent upon foreign sources and ore located farther south in England. Secondly, because of the less favorable raw material position, competition had arisen in other parts of Britain. Finally, foreign countries were at the same time developing domestic steel industries, and the export trade of the Northeast Coast declined significantly. Since World War II, however, and the resultant expansion of the British iron and steel industry, this region has experienced an increase in production based on imported iron ores and the expanding domestic market.

The availability of iron and steel at points where deep water and protected harbors facilitated the launching of vessels made the Tees and the neighboring Wear and Tyne estuaries shipbuilding centers. At the beginning of the present century this area produced about one-half British shipbuilding tonnage. However, as in iron and steel the area gradually lost its dominance (25). The decline is due to a number of factors. As iron and steel output decreased, the availability of local raw materials lessened. Furthermore, after World War I Britain lost a considerable portion of her export market for ships, as other countries developed their shipbuilding industries. Finally, domestic consumption of ships also declined. As a result the shipyards of the three estuaries, and also of Hartlepool and West Hartlepool, declined in importance. With the demand for ships in World War II and the postwar period, the Northeast Coast has recovered as a shipbuilding center. In recent years this area has been producing about 40 per cent of British ships, specializing in particular types of crafts such as tankers.

Besides shipbuilding, the area is noted for its many branches of the engineering industries. In the Newcastle and Gateshead districts of the Tyne, locomotive and other transportation equipment is produced. Sunderland, at the mouth of the Wear, is a machinery center. In the Tees Valley, machine works are located at Stockton, Darlington, and elsewhere.

A growing activity in the area is the production of chemicals. This industry is based primarily on available by-products from the coking process, but is also aided by the presence of salt and gypsum. Originally, lead ore from the northern Pennines was smelted in the area, and acid works were also established.

Eastern Pennines. The Eastern Pennine coal field of Yorkshire is most nearly comparable to the Ruhr in its industrial character, possessing the same vast metallurgical works and textile industries (31). The coal fields were most influential in the localization and growth of manufacturing in the region. However, other factors have also been important, including easy access to the sea, available water power, pure water, and a large, skilled labor force.

Within the region the metallurgical industries are concentrated in the south and the textiles are found to the north. The industry of this region dates back centuries to the original iron industry. The earliest iron industry was based on local iron ore from the coal measures, charcoal from the plentiful forests, and water from the swift flowing streams, which provided power. Within the Sheffield area cutlery making developed because the Millstone grits (a compact sandstone) were particularly desirable for the making of grindstones (20). The precise location of the industry was determined at Sheffield, where the Don River was joined by several tributaries facilitating the assembly of raw materials. Sheffield has maintained its importance as a center of cutlery and plate, and has developed numerous other branches of the steel industries. The area is noted for the output of machinery and armaments.

Yorkshire in the northern portion of the region has a woolen industry, concentrated in the valleys of the Aire and Calder in the area known as West Riding. These valleys have had a woolen industry for centuries. Originally, a series of factors localized the industry. The Pennine streams not only provided power, but supplied abundant soft water from the Millstone grit area. Wool came directly from the nearby flocks of the upland and lowland pastures. With the passage of time the initial factors of localization have changed but the industry has persisted. In the nineteenth century, water power was replaced by coal, and wool is no longer supplied primarily from local sources.

Within the region there is no areal separation of the centers engaged in spinning and weaving, nor are there distinct centers for the manufacture of woolen and worsted cloth. Bradford is the chief center for the manufacture of wool. Much of the emphasis is placed on the weaving of worsted goods produced from long fibers rather than woolen goods made from short fibers. Bradford is also a major center for the buying of wool for the region. It is also engaged in dyeing, finishing, and the sale of finished cloth. Leeds, once the center of woolen manufacture, has gradually developed as an apparel center, using the cloth produced in nearby towns. The apparel industry is now second to the engineering industries, which not only produce machinery for the textile industries, but also such items as locomotives, engines, and aircraft. Other textile towns are Huddersfield, famous for tweeds and high quality cloths, Halifax, specializing in carpets as well as woolen goods, Keighley, and Wakefield. As a whole the West Riding area of Yorkshire has maintained its pre-eminence in worsted goods, while woolen goods are also produced in the west of England.

The Midlands. On the southern edge of the Pennine Range the four great industrial cities of Nottingham, Leicester, Birmingham, and Stoke form the nucleus of the industrial Midlands. The original growth of industry in this area was directly connected with the occurrence of iron ore in the coal measures. The iron ore was worked at an early date, even before coal was commonly used as the smelting fuel.

The heart of the Midlands centers on Birmingham and the surrounding towns of Walsall, Bilston, West Bromwich, Wolverhampton, Dudley, and Coventry (34). These cities essentially form the limits of the "Black Country." The area's metallurgy has its roots in medieval traditions that date as far back as the fourteenth century. In the seventeenth century Birmingham was called "the toy shop of the world." By the nineteenth century this urban agglomeration had developed not only a basic iron and steel industry but also a wide gamut of metal industries. Its products now include motorcars, bicycles, tires and other rubber goods, textiles, apparel, electrical supplies, machine tools, munitions, and food products (44).

During the nineteenth century Birmingham evolved as the leading center for the making of copper and brass articles. The momentum which that city had acquired in the brass and copper trade during the eighteenth century was sufficient to attract new developments. The demand for copper and brass products such as copper tubes and pressure gauges expanded so rapidly that by 1860 brass manufacture was the city's leading industry. Birmingham was particularly well situated for the assembly of raw materials and coal. A well-developed system of canals has been cut through central England, aiding the assembly of raw materials and the marketing of finished products. The city was also conveniently located near certain accessories of brass manufacture such as fire-clay crucibles from the Stourbridge District and local deposits of excellent moulding, or casting sand. The industry has persisted to the present, with smelters at Birmingham and Walsall.

To the east of the Birmingham District are the industrial concentrations of Nottingham and Leicester (27). These cities were established woolen centers centuries before the Industrial Revolution. With the development of the coal fields manufacturing has thrived. Within the textile industry, the area has specialized in the output of hosiery and lace. At an early date the Nottingham District developed a metallurgical industry, based first on charcoal from Sherwood forest and later local coal and iron ore. Although the primary iron and steel industry has declined, the cities of this area produce many metal products. Nottingham is noted for bicycles and in recent years a motor vehicle industry has also developed. Because the region has long been an important cattle area, there has been a local supply of raw material for the tanning and leather industry and associated shoe manufacturing.

To the northwest of Birmingham lies the pottery region of Stoke-on-Trent, known the world over as "The Potteries." From the fourteenth century this area has produced pottery. The early industry, based initially on local wood and clays (and later, coal) produced coarse earthenware, tiles, and drain pipes. By

the early eighteenth century the village of Burslem had become a noted center. As the industry developed, lead and salt for glazing were imported from Derbyshire and Cheshire. For the production of chinaware finer clays were brought by pack horses from Devon and Dorset. Late in the eighteenth century the famous Wedgewood china was developed. The local coal and the skills acquired in firing the crude pottery made it easy to convert the clays into every type of pottery product from common dishes to beautiful works of art. Within the area, about one-third of the workers are employed directly in the potteries, while many others are engaged in making brushes and the color and glazes needed for the pottery.

Lancashire. The Lancashire Region is dominated by a single industry, cotton textiles. The development of the industry was a response to a number of factors. The Manchester area was noted for linen and woolen cloth as early as the fourteenth century. In the eighteenth century the cotton industry began to replace the traditional textiles. The skilled craftsmen of the area provided not only a source of labor for the cotton mills, but also produced the machinery for cotton processing. In the nineteenth century with the discovery of steam coal in Lancashire in the same areas where water power existed, a new source of power was introduced to aid mechanization of the textile industry. The area facing the Atlantic Ocean was 500 miles closer to the main source of cotton in the United States and the West Indies than were east coast British ports. The oceanic conditions also provided the high humidity needed to keep the threads from breaking in the cotton textile mills. Furthermore, the heavy year-round precipitation of the Pennines provided not only a source of power for the early mills but also a plentiful supply of the pure soft water needed in textile manufacturing processes. Finally, salt deposits found south of the Mersey River provided one of the raw materials for the manufacture of bleaches and certain other chemicals used in the textile industry.

In the nineteenth century Lancashire became the textile workshop of the world. The industry was concentrated in two main districts, and within these areas certain centers tended to specialize in particular branches with distinct characteristics. The earliest spinning and carding activity developed in the river valleys, where water power and pure water were available in such foothill towns of the Pennines as Oldham, Rockdale, Bolton, Bury, Stalybridge, and Ashton-under-Lyne. After the invention of mechanically powered looms, weaving mills were established farther north in the Lancashire District at Preston, Blackburn, Nelson, Colne, Burnley, and Accrington in the Ribble River valley, where an excess labor supply still existed. The financial and commercial activities focused on the centrally located city of Manchester. The Manchester Ship Canal was built to connect the city with the Mersey River estuary in order to facilitate movement of raw materials and finished goods to and from the region. Many textile plants developed in the vicinity of Manchester, taking advantage of its central position.

During most of the nineteenth century the Lancaster area enjoyed almost complete freedom from competition in its world market. The region's products were in demand throughout the world. However, within the twentieth century most countries have developed a cotton textile industry. In many areas, notably in the Far East, the cotton textile industry was based on much cheaper labor than in England. The economic foundation of the Lancaster area gradually declined and the cotton towns began to suffer from chronic economic depression. Greater emphasis upon finer quality textiles relieved the situation to some extent for a time, but gradually competition developed in these types of fabrics as well. In 1946 the British government closed the cotton exchange in Manchester. This marked the end of the era of British textile leadership.

As a consequence of the depressed textile industry, other economic endeavors have developed in the region. However, most of the newer industries have evolved nearer the coast than the textile industry. They lie, then, between the sources of foreign raw materials and the coal fields. These newer industries include the refining of petroleum, milling of wheat, manufacturing of chemicals, soap, and margarine, fabrication of iron and steel products, and shipbuilding. It is questioned whether tex-

tiles as a major industry will survive in this region. The coastal position, available labor, and excellent transportation network, as well as the presence of local salt supplies, may make possible a greater diversification of manufacturing in the future.

Northwest Coast. This is one of the smallest industrial regions in Britain. Industry is localized along the coast on the Cumberland coal field. Originally the proximity of coal and high-grade iron ore deposits favored the growth of an iron and steel industry. The ore is an excellent hematite, rich in iron content and nonphosphorous, and is sought for the production of fine steel products in Sheffield, Birmingham, and other places. Blast furnaces have developed at Barrow-in-Furness and Workington. Unfortunately, the sources of local fuel and raw materials are inadequate and the area now depends on the Durham coal field for its coke and Spain for its ore.

Shipbuilding yards have been constructed near the blast furnaces and steel works on the shores of the sound which separates the long, narrow island and Walney from the mainland. Along the shore and on adjacent islands, industrial establishments found adequate space for their developments. At the northern edge of the region the town of Carlisle engages in a certain amount of industry, chiefly cloth printing and machine manufacture.

South Wales. An important industrial district has been created in South Wales based on the availability of coal and the long established metalworking traditions. The deep valleys of southern Wales have exposed the coal seams on their sides, facilitating the early development of mining. The quality of the coal has also been of vital importance. Because of crustal distortion the coal varies from bituminous to anthracite. In the eastern portion of the field bituminous coal suitable for domestic heating and making of coal gas is found. In the central section from Ebbw Vale to Ogmore there is a high-grade bituminous coal suitable for coking and steam purposes. On the northwestern margin, the coal fields yield anthracite which is particularly desired by industrial consumers (43).

The changing functions and developments of the three coal districts are primarily due to the character of the coal in each. The iron and steel industry had its origin in the central section where the coal measures also contained iron ore. The initial fuel utilized being charcoal from the forests then growing in the valleys. Later charcoal was replaced by coke from local coal. The valleys then became important mining as well as iron and steel centers, lined with towns such as Merthyr Tydfil, Dowlais and Ebbw Vale. The congestion of mining and metallurgical activities created one of the world's dreariest industrial landscapes.

On the coast, such cities as Cardiff, Newport, and Swansea developed where natural harbors existed. At the beginning these ports exported coal, iron, and steel, since they were placed at the natural outlets of the interior valleys. With the depletion of local iron ores, foreign ores were imported through these ports. It thus became economical to send the coal to the coastal cities where iron ore entered the country and establish blast furnaces at these intermediate points. As a result the interior towns gradually declined as metallurgical centers. As the best coals on the northern margin of the region became exhausted, mining tended to migrate down the valleys. In recent years the area has not been self-sufficient in iron and steel, and these metals have been imported for fabrication in plants situated near the ports.

Another industry of importance is that of nonferrous smelting, resulting in the establishment of tin plating and galvanizing industries. This group began when tin was obtained from Cornwall. The tin ore was easily transported for smelting by a short and cheap water haul to the nearest source of coal. Although the local ores are depleted the industry has remained, because of acquired skills, available anthracite and water, and existing facilities. Since the ores must be imported and most of the finished products exported, a coastal location is greatly desired. The plants are grouped mainly near the mouth of the Neath River at and below the town of Neath, in the lower part of the Tawe Valley near Swansea, near Llanelly, and near Port Talbot. Of the nonferrous products tin and zinc plate and galvanized metal have maintained a large export market. As a result, these plating industries have thrived, and have sustained a region that might otherwise have declined.

In recent years a large petroleum refining industry has been established at such places as Swansea, based on imported crude oil. The basic chemical industry has also been expanding. For example, sulphuric acid is one of the by-products of the nonferrous smelters.

London Basin. The London metropolitan area is not only a major center of trade and commerce, but also a manufacturing district (45). London is the largest British center of such industries as engineering, apparel, and chemical manufacturing. A vast variety of industries are found in London and its immediate suburbs. No one type of industry dominates in London as in Lancashire or "The Potteries." The heavy metallurgical industries and textiles, which are key occupations in the country's industrial regions as a whole, are absent.

In other sections of Britain the availability of coal is a major factor in localizing industry. Coal is not found directly in the London area and other factors must be sought to understand its industrial growth. Metropolitan London now has about 10 million people. The demands of such a large population provide a tremendous market for manufactured goods. Many industries such as foodstuffs and apparel have grown out of the importance of the local market. Another factor in London's industrial growth lies in the advantages of its transportation position. London is built at the head of navigation on the Thames. Foreign raw materials and fuels are easily assembled by water and a group of industries has grown along the Thames River docks. These include sawmills, soap works, sugar refineries and chemical works at such places as Rotherhithe and Deptford. A government munitions factory is at Woolwich. Below Woolwich on the Thames at such places as Purfleet, Northfleet, Kemsley, Gravesend, Dartford and Erith are establishments producing fertilizer, rope, sugar, flour, and rubber goods. More than half of the cement and paper of Britain is manufactured in the Lower Thames District.

London is well served by land transportation, with a network of roads and railways radiating to all parts of Great Britain. No other British city is comparable in its transportation facilities. In recent years the greatest industrial development has occurred north and west of London along the road and rail routes. These factories assemble their raw materials from the London dock area as well as from the interior industrial centers. They are thus market oriented with their specific site to take advantage of ease of raw material assembly. The industries are also well-situated for an export trade by being near the port of London.

The growth of a large and skilled labor supply has likewise been a major force attracting new industry to London. The diversity of industry is a continuing factor in the growth of the area in that like industries attract like industries. Many firms have migrated to London in recent years because of the favorable economic environment exhibited by an existing industry.

BELGIUM

Belgium was the first country on the European continent to be industrialized. During the Middle Ages industrial townships were founded, originating with the manufacture of cloth and metals, along with sea-borne trade. Because of this rich tradition of established textile and metallurgical centers, the Industrial Revolution made rapid strides. As a result the Belgian economy has long been predominately industrial, relying to a high degree on international trade. The country imports most of its industrial raw materials except coal. A large percentage of these materials are processed and then re-exported. Of the gross national product, manufacturing supplies about 30 per cent of the total.

Industrial Structure

About one million people are engaged in Belgian manufacturing. Of the industries, basic metals and engineering dominate, having 16 and 24 per cent respectively of the total employment. Textiles are third in importance with 12 per cent. The chemical, woodworking, apparel, and food processing industries each have between 5 and 8 per cent of the total employed in manufacturing.

Of the metal processing industries, iron and steel are the most important. Although these industries are ancient, they have not become static. Output of pig iron rose from 3,929,000 tons in 1948 to 5,965,000 in 1959, and steel production increased from 3,920,000 tons to 6,433,000 in 1959. Nearly 60 per cent of Belgian steel is exported. Most of the iron and steel industry is located on the coal fields in the Liége and Hainaut basins. Steel mills are also found on the northern fringes of the Luxembourg iron ore deposits.

The nonferrous metals industry of Belgium is a prime example of an industry based on imports. Smelters and refineries process copper, lead, zinc, and tin ores, primarily for export. The industry is concentrated in the coal basins, and owes its importance to its excellent market position in Europe.

The engineering industries have developed both as an adjunct to the metal industries, for whose products they provided the first stages of processing, and as a subsidiary to the expansion of textiles and the metallurgical industries, which created a demand for machinery and apparatus. Industrial equipment has always played a significant role in Belgium's mechanical engineering industries. These industries have increased their importance steadily in the twentieth century. Such Belgian products as machine tools, railway rolling stock, and heavy and electrical machinery are marketed throughout the world.

In contrast to the metal industries the textile industry, concentrated in Flanders, has experienced a long decline. It is based primarily on an export market and with the world growth in textiles its markets have gradually disappeared. Output of cotton yarn declined from 117,700 tons in 1951 to 97,500 tons in 1959. In order to offset the general decline, Belgian textile manufacturers are developing a higher calibre of processing and an increased sale of finished textiles.

The Belgian chemical industry is well developed. About one-half of its output is exported. The industry produces heavy chemicals, explosives, paints, dyestuffs, pharmaceuticals, and fertilizers. A major source of raw material for this industry is from the by-product coke ovens associated with the iron and steel industry.

Manufacturing Regions

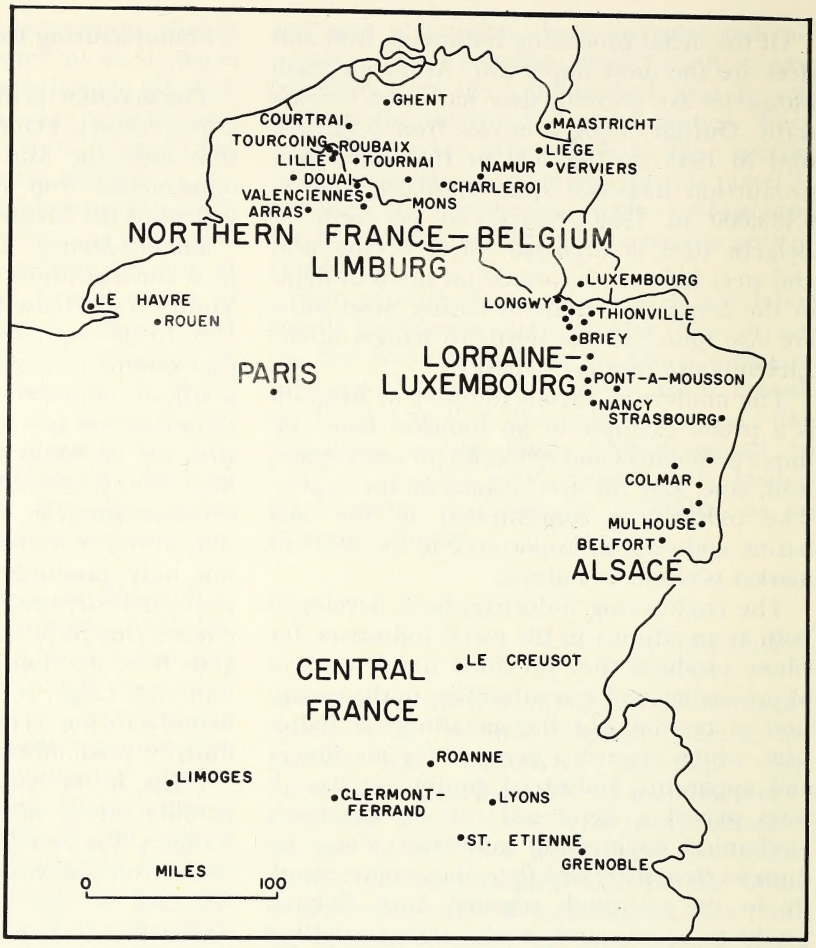
The manufacturing regions of Belgium have a long history. Flanders has specialized in textiles since the Middle Ages, and from time immemorial iron has been worked in the valleys of the Meuse and Sambre rivers.

Sambre-Meuse Lowlands. Major industrial concentrations occur in portions of the Sambre and Meuse rivers from Mons to Liége (46). In the west, Mons was one of the earliest coal mining centers developed in Europe and is still an important producer. Manufacturing industries are less important in the industrial structure of Mons than mining but the area does process coal into coke, and also produces earthenware. The Charleroi District, lying a short distance to the east in the Sambre Valley, not only produces coal, but is one of the heavy industry centers of Belgium. Metallurgy, engineering industries, chemicals, pottery, and glass have developed. Located between Charleroi and Liége, Namur is the most important manufacturing center where mechanical industries predominate.

Liége, to the east, is one of Europe's oldest manufacturing districts. The iron and steel industry was founded here in the Middle Ages when iron ore was mined and processed. The smelting of zinc and silver, mined in the Ardennes, was later added to the metallurgical industries. In the eighteenth century the processing of coking coal was introduced from England and a modern iron and steel industry evolved. The area now specializes in quality steels, producing such products as cutlery and weapons.

In the valley of the Vesdre is the old textile town of Verviers. A woolen industry was established here in the eighteenth century. Shortly afterward this area secured the first mechanically driven textile mill on the continent. The Verviers area now produces more than half the woolen goods of Belgium, and washes and prepares much of the wool used in other Belgian centers. Glass is also a product of the area.

Because the coal seams of the Sambre-Meuse valleys have long been exploited, the area now faces a coal shortage. The remaining reserves are small, the mines are old and deep, and the seams are thin and steeply inclined so that



3.3. Manufacturing Regions of France, Belgium, and Luxembourg.

they do not lend themselves easily to mechanized mining. Fortunately, the region is close to the newly developed Campine coal field in northeastern Belgium. Here the seams are much thicker and the reserve much greater. In addition, the new mines are well equipped with modern mining machinery and are efficient producers. The metal mines of the region are also exhausted, so that ores are now imported from outside.

Although the Belgian resource base is declining, the area remains a major heavy industry region. The development of an excellent transportation network has favored manufacturing. The geographical narrowing of the northern European plain caused routes to converge in this region, giving it not only access to raw materials but also to widespread markets. The nearness to North Sea ports has facilitated international trade. Furthermore, the region is situated in the midst of one of the world's greatest markets for heavy manufactured goods.

Flanders. To the north of the heavy industrial zone is the textile area of Flanders. The textile industry has been pursued by the people of this region for centuries. In the Middle Ages the availability of local wool and flax formed the raw material foundation for the industry. However, the woolen industry survives only at such towns as Ghent, Kortrijk (Courtrai), and Eeklo, where specialty products are produced. Much of the industry migrated to the Verviers area east of Liége in the fifteenth century. The linen industry continues to flourish in the Lys Valley at Armentières, Wevelgem, Kortrijk and Ghent. This industry is based on locally grown flax, the pure water of the Lys for retting (the process of separating the bast fibers of flax by fermen-

tation from the surrounding woody and other stem tissues), and a large experienced labor force. Because of the industry's growth, about 80 per cent of the flax must now be imported.

As other fibers became important, they were introduced in Flanders. As a result linen declined and cotton became the pre-eminent textile in Belgian Flanders. In their initial stage textiles grew as a dispersed rural industry in order to give employment to the expanding rural population, particularly during the long winter months of farm inactivity. With the growth of cotton textiles the modern pattern of distribution was established, with the centralization of the industry in a few areas. Ghent became the capital of cotton textile manufacture and now possesses more than half of the spindles. The industry is also found in the valley of the Scheldt at Oudenaarde and Ronse and in the Dender Valley at Aalst, Ninove, Geeraardsbergen, and Ath. A wide variety of cotton fabrics is produced, including certain specialties. For example, Ghent, Aalst, and Dendermonde produce cotton blankets for use in the tropics.

As a response to the skilled labor and long traditions, other textiles such as silk, hemp, and synthetic fibers are now produced in the area. They are found in essentially the same centers as cotton with Ghent and Kortrijk dominating. A vast range of associated industries use the area's yarns and cloth. For example, almost every town in Flanders possesses some branch of the textile industry.

In recent times the larger industrial centers of Flanders have developed a diversified manufactural economy. In Ghent textiles account for only half of the industrial employment. Chemical products, particularly electrochemicals and dyestuffs, along with fertilizers, glassware, and a wide range of metal products are produced. Some industries are based on imports, such as paper, woodworking, and the tanning and leather industries.

Isolated centers. The cities of Antwerp and Brussels, lying outside major manufacturing zones, deserve attention. Antwerp is one of Europe's major ports. A variety of industries has developed in the area. The engineering and metallurgical industries include shipbuilding, marine engineering, heavy machinery, and the construction of cranes, bridges, and nonferrous metallurgical products. A large number of industries such as the production of soap, chocolate, rubber goods, tobacco, and flour are based on imported raw materials. The largest petroleum refineries in Belgium are at Antwerp. The nonmetallic industries are represented by glass, pottery, brick, and cement. The cutting of diamonds, established more than a century ago, is of major importance and Antwerp now exceeds Amsterdam. A great variety of consumer goods is also produced in Antwerp. The diversified industry of this city is based on a number of factors. The port position provides for the economical assembly of raw materials and distribution of processed goods. An excellent land and canal transportation system gives access to the markets of the European continent. The large local population provides not only an immediate market, but also a skilled labor force. Finally, the city has a long tradition of industry, and the quality of its manufacturers is widely known.

Brussels is not only a governmental and commercial center, but also an industrial city. Its industries are extremely varied, based to a large degree on its skilled labor force and excellent market location. Of its manufactured goods, engineering products, textiles, chemicals, paper, furniture, and consumer goods are of importance.

FRANCE

France is one of the major industrial nations of Europe, being exceeded in output only by the United Kingdom and West Germany. Traditionally, France has been noted for its quality products, where skill is of considerable importance. For example, although France produces a wide range of textiles, it has gained its reputation in the field of fashion fabrics. Handicrafts have frequently played an important role and the small artisan's establishment has been typical of many branches of French industry. The industrial traditions of the past now appear to be disappearing. Modern factory methods, such as mass production techniques, are rapidly being introduced into the French industrial economy. For the first time

in French history manufacturing now employs more workers than agriculture.

Industrial Structure

French manufacturing has been undergoing a dynamic expansion since World War II. If 1953 has an index number of 100 in manufacturing, 1938's level stood at 76 and 1959's had reached 152. Of the individual industries chemicals rose most rapidly, from 57 in 1938 to 204 in 1959. Metal products had nearly as great a rise, going from 53 to 171 during this period. In contrast, the textile industries rose only from 99 to 110 from 1938 to 1959. Employment in French industry now totals about five million workers.

Iron and steel industry. The basic iron and steel industry of France has expanded rapidly in recent years. The output of pig iron rose from 6,628,000 tons in 1948 to 12,651,000 tons in 1959, while steel rose from 7,236,000 tons to 15,219,000. About two-thirds of the iron and steel industry is localized near the Minette iron ore deposits of Lorraine which have an iron content of 24 to 44 per cent (51). In effect, the production of one ton of steel requires three tons of iron ore and 1.4 tons of coal. It is evident in relation to raw materials that it is advantageous to install the blast furnaces at the site of the iron ore and transport the coal to this area. The vast iron and steel works of Lorraine are concentrated in Neuves-Maisons, Pompey, Homecourt-Joeuf, Hagondange, Hayange, and Longwy. A continuous strip rolling mill has been built at Thionville. The Lorraine iron and steel industry employs about 80,000 workers.

A number of smaller iron and steel centers exist in France. In the North, an iron and steel industry is oriented to coal resources. Major centers of production include Denain, Montataire, Valenciennes-Anzin, and others in the valley of the Scheldt. In the Central Region, St. Étienne is a primary iron and steel center also oriented to local coal deposits. Small iron furnaces which utilize local ore deposits are found in a number of areas such as Les Dunes, Rouen, Givors-Chasse, and Fumel. Electrolytic steel furnaces have developed in the French Alps and Pyrenees based on low-cost hydroelectric power. These centers include Ugine-Moutiers, Allevard-Le Cheylas, Les Ancizes, Saint-Chély-d'Apcher, Pamiers, and Imphy.

Engineering industries. The engineering industries, with more than 1,370,000 workers, have more than doubled their output between 1938 and 1960. Of these industries the largest group of workers are employed directly or indirectly in the output of transportation equipment, of which the motor vehicle industry has experienced considerable growth. The production of automobiles and trucks has increased from 198,400 in 1948 to 1,283,300 in 1959. About 225,000 workers are employed directly in the industry. The industry is primarily concentrated in the Paris area, but in recent years with increased production and expanded market throughout France a decentralization is occurring. Factories are now located at Le Mans, Rouen, Rennes, Strasbourg, Sochaux, Berliet, and near Lyons.

Contrasting with the automobile industry, the construction of motorcycles, scooters and bicycles is localized outside the Paris region. Since 1950 there has been a decline in bicycle production and an increase in motorcycles and scooters. St. Étienne, the traditional center of bicycle production, has been slow in changing from bicycles to motorized units and has thus declined in importance. The principal centers for the manufacture of motorcycles are Courbevoie, St. Quentin, and Beaulieu. Fourchambault, Dijon, and Troyes are noted for scooters, and Vichy makes motors.

The aircraft industry is largely nationalized and its importance is closely related to the nation's defense program. About 80,000 workers are in the industry. The manufacture of motors is concentrated in the Paris area and at Bordes. Toulouse has become an aeronautical center, with 8,000 workers. Other plants have been built near Nantes, Bourges, and Marignane. Locomotives and rolling stock are largely produced in the North, oriented to a supply of steel.

The electrical machinery industries, employing more than 200,000 workers, more than doubled production between 1950 and 1960. The industry is concentrated in the Paris area, the French Alps, and the Pyrenees. Centers of

production include Grenoble, Tarbes, Bazet, and Angers. The localization in the Paris area reflects the major market for such items as telecommunication equipment, radios, and television sets. The Alpine concentrations are centers for the production of hydroelectric generating equipment.

In recent years agricultural machinery has increased greatly in importance. Notable in this growth has been the increase in power equipment, particularly tractors. This industry is rather widely dispersed, being chiefly found in the most prosperous agricultural regions. Principal centers are located at Le Mans and St. Dizier.

Other important branches of engineering include machine tools, precision instruments, watches, and foundry products.

Chemical industry. The chemical industries, employing more than 235,000 workers, produce a wide variety of products. The basic chemical industries of France illustrate present-day trends. The sulphuric acid industry, based partly on the Lacq sulphur deposits, has increased production from 1,275,000 tons in 1948 to 1,827,000 in 1959. France possesses enormous reserves of salt in Lorraine and Franche-Comté. This salt forms the base for such chemicals as soda and chlorine. The production of caustic soda is concentrated in Lorraine at Dombasle and Varangéville and in the Jura at Tavaux. The chlorine industry is frequently located near salt deposits and where low-cost hydroelectric power is available. Chlorine is also produced in diversified chemical centers where it forms a base for other chemical products. Because chlorine is not easily transported it is frequently oriented to its market.

A number of other chemical industries are in a rapid state of expansion. The electrochemical industries, concentrated in the Alps and Pyrenees areas, produce such products as calcium carbide and corundum. The organic chemical industries have also developed based on by-products from the coking of coal. This industry is allied to the iron and steel centers. In recent years the petrochemical industry, associated with petroleum refining has become significant. A wide range of synthetic products, such as plastics, detergents, textile fibers, and plexiglass are now produced. The Lyons Region has become known for its synthetic fibers and pharmaceuticals.

In the past France was a relatively small consumer of chemical fertilizers. With the attempt to increase output since World War II, the use of these fertilizers has grown rapidly. The output of synthetic nitrates has grown 2.5 times since 1938. The major centers are in the North and at Toulouse, oriented to low-cost electrical power. The phosphate industry has also expanded, based partly on imports and partly on slag from blast furnaces which utilize the phosphorous Lorraine iron ores.

Textile industries. The textile industry, as a whole, has experienced a long period of economic crisis. Employment in the industry has declined from 920,000 workers in 1930 to about 410,000 in 1961. Of this number, about 100,000 are in cotton textiles, 80,000 in woolens and worsteds, 75,000 in synthetics, and 69,000 in hosiery and knit goods. Although employment has declined, output has grown slightly due to a rise in productivity. Nevertheless, textiles remain a problem industry.

Textiles play an important role in a number of areas of France. Of these the North is the principal textile region, with about 100,000 workers. A wide variety of textiles are produced, but particular branches of industry are concentrated in certain centers. Roubaix is world-renowned for its wool products. Lille and Tourcoing are oriented to cotton, and Armentières specializes in linen.

The Vosges Region of Alsace is the major cotton textile producing region of France. The industry concentrated in the valleys around Mulhouse. This is essentially a one-industry region and in recent years has suffered from partial unemployment.

In the Lyons area and the nearby towns of the Central Massif, the silk industry was early established, but has now practically disappeared. In its place Lyons has become a center of synthetic fibers. The mills of the Ardèche and Dauphiné have prospered, being based on the nylon industry. The hosiery and knit goods industry of the Department of Aube, with a concentration in Troyes, is the largest center in France, with about 25,000 workers. The Cévennes constitutes another hosiery producing area.

Manufacturing Regions

Manufacturing in France traditionally has been concentrated in a few areas (Map 3.3). Of the factors localizing industry, market is of the greatest importance in Paris. The industry of Lorraine is oriented to raw materials of iron ore and salt. In the North the industrial region is closely associated with coal deposits. In Central France a number of factors have influenced the industrial pattern. Coal and iron ore have created heavy industrial centers and hydroelectricity has been influential in bringing industry to the Alps. In general most of the French industry is located in the north and on its eastern border. Western and southern France have developed specialty industries such as shipbuilding and petroleum refining but these areas lack general industrial development.

Paris. Paris occupies a pre-eminent position in French manufacturing. It has more industrial workers than the Northern and Lyons industrial districts combined. Manufacturing began in Paris during the Middle Ages when skilled craftsmen were attracted to the city. As Paris assumed the position of chief governmental and cultural center of France, the demands for quality goods expanded greatly. At an early date Paris became world-renowned for its production of jewelry, furniture, perfumes, leather goods, and a host of other articles that made the French palatial home the finest in the world. This type of industry has remained to the present day and is particularly exemplified by the modern women's clothing industry. Paris styles and garments are internationally recognized for their quality.

Although "articles de luxe" are traditional, Paris has developed a highly diversified manufacturing economy. The traditional industries are situated in the heart of the city. In contrast the newer ones are located on the periphery in industrial suburbs, particularly on the north and along the Seine River. Paris manufacturing is based not on the presence of local raw materials or fuels, but on the availability of skilled workers, a huge local market, and its position as the hub of French transportation. This gives Paris an advantage possessed by no other French city, not only in the assemblage of raw materials but also in the distribution of the finished goods.

The engineering industries are well represented by factories producing automobiles, rolling stock, electrical equipment, machinery, and light metal fabricated products. Because raw materials are relatively scarce and must be assembled from distant areas, many industries are characterized by their small consumption of raw materials and high value such as scientific instruments and machine tools. Other branches of manufacturing include petroleum refining, fertilizers, foundry products, cement, printing and publishing, rubber goods, and food processing. This is by no means an exhaustive list of manufacturing in the Paris area, but illustrates its great variety.

The North. In Northern France an industrial zone has developed in the Departments of Nord and Pas-de-Calais. Within this area two industrial districts can be identified—the heavy metallurgical zone of the Scheldt Valley and the light industry area of French Flanders. In actuality this region is the westward extension of similar regions which exist in Belgium.

The heavy metallurgical industry is based on availability of coal from one of Western Europe's most important coal areas, which extends for more than 100 miles from western Germany to northern France. The coal does not occur continuously, and the quality also varies considerably. In France the main concentration of iron and steel production lies around Valenciennes and the canalized Scheldt Valley to the west. Other centers are situated on the coal fields of Douai and Hénin-Liétard to the northwest. The coal of this region is largely noncoking and must be supplemented by imports. The area also lacks iron ore, which is secured by rail from Lorraine and Luxembourg and by sea through the port of Dunkerque from Norway, Sweden, and Spain. Because raw materials must be imported the region emphasizes the production of steel rather than pig iron. In 1960 the area produced about 1,700,000 tons of pig iron but nearly twice this amount of steel.

Because of the availability of steel the growth of metalworking industries has been favored. Valenciennes is noted for its output of foundry and rolling mill products, mining and heating equipment, and bicycles. Denain

produces railroad rolling stock and armaments. Other engineering industry centers include Douai, Lens, Bruay, and Béthune.

The textile industry of this area has been practiced by the people of Picardy for centuries. It grew as a dispersed rural industry in order to give employment to an expanding rural population, particularly during the long winter months of farm inactivity. Its growth was also favored by the availability of raw materials. Linen cloth was made from flax produced on nearly every farm, and woolen garments were woven from the wool of sheep that wandered in flocks through the region.

In the nineteenth century the modern factory system developed and the textile industry was concentrated in a few centers. Except for minor development at Valenciennes the textile industry is not situated on the coal fields but lies primarily to the north. With the development of the modern industry, cotton textiles have become the most important, with Lille, the dominant center, specializing in muslins, voiles, and ready-made clothing. The Roubaix-Tourcoing agglomeration is the traditional woolen center, but now also produces clothing, hosiery and other knit goods, carpets, tapestries, and furnishing fabrics. In recent years the use of synthetic fibers has been growing in importance. The region as a whole is expanding at the expense of several other textile districts in France, especially those in the southern portion of the country. This is primarily due to nearby coal for power and the large market of northern France.

Within the textile centers in recent years there has been the establishment of numerous metal fabricating and engineering industries. Lille is noted for its textile machinery and also agricultural equipment for the rich farming regions of northern France.

Lorraine-Luxembourg. The industrial area of Lorraine-Luxembourg stretching from Nancy on the south to Luxembourg on the north is noted particularly for its heavy metallurgical and chemical industries. The development of modern industry in this area dates from the latter part of the nineteenth century. Prior to the discovery of the Thomas-Gilchrist process in 1878, the high phosphorous content iron ores of Lorraine could not be utilized in the making of steel. It was only after the development of this process that the metallurgical industry of Lorraine flourished.

Today the iron and steel industry is based on local iron ores and to a lesser extent on the coal of eastern Lorraine (51). A portion of the coking coal must still be imported from the Ruhr of western Germany and other foreign sources. The Lorraine iron ore deposits, the largest in Europe, extend for 60 miles from north to south, having a breadth of over 25 miles in the north, but narrowing to only six miles in the south. The ores are not rich in iron content, varying from 24 to 42 per cent, and averaging about 33 per cent.

The iron and steel industry is concentrated in the Moselle Valley and its major tributaries and in the Longwy iron ore basin on the Lorraine-Luxembourg border. The valley localization is due to the availability of better transportation facilities, including railroads and canals. The iron and steel industry of Lorraine-Luxembourg is modern, with a number of completely integrated plants. A striking complex of industrial establishments lines the valley bottoms. Because industry developed rapidly, there has frequently been a labor shortage in this area. Migrant workers from Italy, Belgium, Poland and other nations have produced a heterogeneous population in the industrial settlements.

The Lorraine area is noted for the production of basic metal. The fabricating industries are relatively small. This is an excess steel producing area, and much steel is sent to other French regions, particularly to Paris, and to foreign countries as well.

The chemical industry of Lorraine is older than that of metallurgy. Salt, mined in the Lunéville area for centuries, now forms the basis for a thriving chemical industry. Plants of the great Solvay works are established in more than a dozen towns.

Most of the industrial centers of Lorraine-Luxembourg have emphasized the production of metals or chemicals. In contrast, Nancy, the leading city in the area, has developed diversified industries such as textiles, glass, furniture, electrical machinery, and leather. Some of these industries were founded on the availability of raw materials, such as glass sand and bark from neighboring forests for the tanning of leather. Although these resources

are largely depleted, the availability of iron and steel and acquired skills are now the most significant factors fostering present-day developments.

Alsace. Alsace is one of the traditional textile centers of France. It began as a home industry in the Vosges Mountains with the making of linen cloth from local flax. In 1746, the first industry—the production of painted linen—migrated from Switzerland to Mulhouse. In order to supply this industry, it was necessary to install spinning and weaving machinery. Although linen was the first textile product, the making of cotton cloth was introduced in the eighteenth century and soon dominated output. In these early stages the industry spread throughout the Vosges seeking the better water-power sites in the mountains. With the growth of electric power in the latter part of the nineteenth century, the factories were no longer limited to the mountains and have since been concentrating on the Rhine plain because of better transportation facilities.

The textile industry of Alsace suffered greatly during both World Wars. Not only was physical destruction considerable, but lack of fiber imports resulted in the near-stoppage of the cotton industry. After the war periods, recovery occurred and this region now produces about one-quarter of the nation's textiles. Mulhouse is the center of the industry, with cotton textiles being the most important —but wool, silk, and synthetic fibers are also produced. This is in contrast to many of the smaller centers in the Vosges which have specialized not only in a particular type of fabric but also in special processes such as bleaching, dyeing, or spinning.

Mulhouse has also specialized in quality engineering products such as machine tools and textile machinery. This specialization has spread to such smaller centers as Tagolsheim, Altkirch, and Belfort where such diversified engineering products as locomotives, turbines, diesel engines, electrical machinery, and typewriters are produced.

This area contains one of the world's largest deposits of potash, located at the southern end of the Rhine rift valley near Mulhouse. Exploitation of these deposits has made France one of the world's major producers. Since World War II many of the mines have been modernized and facilities for handling concentrates improved. The fertilizer industry is now of major importance.

Central France. A number of industrial centers have developed in Central France that are widely dispersed. No great manufacturing region exists, but industry has evolved where conditions such as available resources or adequate transportation are particularly favorable.

On the northern periphery of the Central Massif a number of industrial concentrations have flourished. The metallurgical centers are situated in the basins of Le Creusot, Montluçon, and St. Étienne. Each of these areas possesses bituminous coal reserves and St. Étienne has small iron ore deposits. Here the iron and steel industry has been oriented to raw material and fuel. However, resources are limited and the primary iron and steel industry remains relatively small. To compensate for the lack of raw materials, considerable skill and experience are applied in producing such articles as cutlery, small arms, machinery, and other complicated metal products.

Another node of industry is found in Clermont-Ferrand. These cities, long important as market centers, began in the nineteenth century to produce rubber products. With the growth of the automobile industry the making of rubber tires flourished. Major tire factories now stretch from Clermont to Ferrand, a distance of several miles. The expansion of the rubber industry has encouraged the introduction of other chemical industries, especially the making of sulphuric acid. Clermont also possesses large mechanical engineering works, bronze foundries, and textile factories.

On the northwestern edge of the Central Massif the city of Limoges has produced works of art for centuries. An enamel pottery industry is nearly a thousand years old. Its origin is sometimes attributed to the Venetian trading colonies which existed there from the eleventh to the fourteenth centuries. This industry owes its existence to local kaolin deposits. Limoges china, renowned for its quality, has been widely exported.

On the eastern edge of the Central Massif within the Rhone-Saône corridor is the strategically located city of Lyons. This city has long

been a center of east-west and north-south land and water routes. As one of the most important industrial centers of France, Lyons has been known since the Middle Ages for the manufacture of silk. This industry was started by Italian immigrants and it was soon found that the mulberry tree thrived in the region so that raw silk was produced locally. For several centuries Lyons was the chief European market for raw silk. The raising of silkworms in France has declined greatly because of the small profit it offers, even though it is encouraged by a state subsidy. The organization of the silk industry remains in Lyons but silk manufacture has spread far and wide from the city, migrating to the towns of the Central Massif and the Alps. In recent decades the silk industry has gradually been replaced by cotton and synthetic fibers.

The textile industry attracted other activities to this area. One of the earliest of these was the chemical industry, which produces dyes and bleaches for textiles. The chemical industry was also fostered by the availability of pyrites for producing sulphuric acid. With growing skills and established markets the number of chemical products increased. Consequently, the region is now known for its wide variety of chemicals.

The metallurgical industries have also developed in this region. Since this area lacks the basic raw materials for a primary metals industry, secondary processing has always been most important. The St. Étienne area immediately to the west of Lyons has been a major supplier of iron and steel to this area. Lyons also possesses foundries for processing steel, copper, bronze, and aluminum. At an early date textile machinery was produced, and because this was a transportation center, railroad equipment and boats were made in the nineteenth century. Soon, other types of metal products were being fabricated, and this area is now noted for its diversified industries.

Within the Central Massif, the textile industry is widely distributed. This type of manufacturing began at an early date as a home industry based on the local availability of wool and silk. In recent years factories have centered in a number of towns. The production of silk and, more recently, synthetic fibers is concentrated in the St. Étienne District, which specializes in the making of ribbons. Roanne manufactures a variety of cotton, woolen, and silk textiles. Le Puy is the center of an ancient lacemaking industry, by which rural women supplement the meager farm income. Although there is still a lace handicraft industry, the development of lacemaking machinery has dealt a serious blow to the making of lace by hand. On the whole, the textile industry of this region has declined with the expansion of the textile industries of northern and eastern France.

A manufacturing zone has also developed in the northern portion of the French Alps, with Grenoble being the center. The growth of industry in the mountainous country is directly related to the availability of low-cost and plentiful hydroelectric power (49). The high elevations, large glaciers, and heavy precipitation make the northern French Alps the largest single source of hydroelectric power in France. The utilization of this potential began about the turn of the century. These early hydroelectric plants were small and operated largely on the natural flow of the Alpine streams. In the 1930's as the demand for electricity grew, several reservoirs were constructed in the French Alps to increase the power output. Development languished during World War II, but since 1945 has progressed rapidly. New plants center on the Isère River, the largest of the east-branch tributaries of the Rhone.

As a result of available hydroelectric power, the northern Alps area has become the major center of French electrometallurgical industries. Aiding the growth of the aluminum industry, the area also possesses the mammoth bauxite deposits of the department of Var in the southern French Alps. This is one of the largest bauxite sources in the world, and has been exploited from an early date.

Electrochemical industries are well established in the Alps. Grenoble was the first major center but these industries are now migrating into the high valleys in order to have direct access to power. Also, the making of cement is an old, established industry. The limestone for the cement is mined near Grenoble, and the area now produces about 25 per cent of France's cement.

Other industries have also thrived. Grenoble

is the chief glove making center in France. The raw material comes from the pasturage activities of the Alps, with lamb skins being the most important. The textile industry, largely silk and synthetic fibers, is widely distributed in this area. Plants have been built in the smallest villages in order to secure labor cheaply. All plants are operated with electric power. In more recent years enginering industries have developed in order to provide machinery for the electrical, textile, and glove factories.

The development of manufacturing in the Alps illustrates the influence of power in the establishment of industry in isolated areas. In the present century the inaccessibility of the area has been overcome by a costly development of roads and railroads. This was a necessity, since the products manufactured are marketed almost exclusively outside the Alps.

Pyrenees. The availability of hydroelectric power is the most important single factor attracting industry to the Pyrenees. High mountains and copious precipitation, particularly in the Central and Atlantic portions, give the area a high power potential. Because of the region's isolation, development of the power resources was long retarded. Although the first power station was built in 1901, significant development did not begin until after World War I. There are now 96 hydroelectric power stations in operation, grouped along the main valleys. Emphasis has been placed on the development of a large number of small stations.

The availability of power has attracted the electrochemical and electrometallurgical industries. Chemical plants producing nitrates and phosphates are located in the Gave de Pau at Soulom and Pierrefitte-Nestalas. Carborundum is made at Sarrancolin in the Arve Valley. Marignac near the Garonne-Pique confluence produces explosives. The aluminum industry has plants at Auzat and Sabarat in the Vicdessos Valley, and at Beyrede in the Aure Valley.

A small iron and steel industry has flourished in the region since 1876. The industry utilizes local hematite of 50 to 60 per cent iron content, found in the Ariège Valley near Vicdessos and Rabat, and at Canigou. The industry has grown in recent years, with iron ore production increasing from 130,000 tons in 1946 to over 300,000 tons in 1960. The blast furnaces are located at Tarascon and Pamiers. Electrolytic furnaces have been introduced in recent years and the area now produces about 25,000 tons of high quality steels. Specialty steels are also made at Rebouc, alloys at St. Antoine and ferrosilicates at Mercus.

The most important concentration of manufacturing centers is the triangle formed by the cities of Tarbes, Lourdes, and Bagnères-de-Bigorre. Tarbes and Bagnères are noted for their electrical and mechanical engineering products. An aircraft factory is found at Ossun, between Lourdes and Tarbes. Insulators are produced at Tarbes.

Besides modern industries, traditional handicrafts still persist in the isolated mountainous regions. These include the spinning and weaving of cloth as well as the wood-using industries, which produce clogs and sabots, furniture, rosaries, and religious statuary. The home textile industry has provided the base for a widespread modern industry of cotton and (originally genuine but now synthetic) silk fibers. Important concentrations are found at Campan and Bagnères-de-Bigorre in the Adour Valley, at Nay on the Gave de Pau, at Ancizan and Sarrancolin in Aure Valley, and at Lavelanet on a tributary of the Ariège.

FEDERAL REPUBLIC OF GERMANY (WEST GERMANY)

Handicraft industries have been practiced for centuries in Germany. By the Middle Ages nearly every town possessed crafts producing for the local market. In a number of the larger cities specialized industries were developed based on the assembly of raw materials from considerable distances and the marketing of products throughout Germany. These early industries included iron and glassmaking and metalworking in gold, silver, copper, and tin. In the fifteenth century textile industries based on wool, linen, and silk were developed as home industries in Westphalia and at such centers as Ulm, Augsburg, and Nürnberg. The textile industries were encouraged by the availability of raw materials and the immediate market, as well as by the inheritance laws, which required that the land be equally

apportioned among all sons. As a result many individuals did not have sufficient land with which to provide for basic family needs. Spinning of yarn and weaving of cloth gave some additional income. There was also the development of other handicraft industries such as wood carving in the mountains of the Black Forest and at Württemberg. On the eve of the Industrial Revolution in Germany, the major centers of industry were situated along the northern border of the Central Uplands in the Weser Uplands; the Harz, Sauerland, and Eifel regions; the Sieg Valley; and, in the south, in the Black Forest, Vosges, and Franconian Jura regions.

The Industrial Revolution came late to Germany. It was initiated by the development of railroads in the 1840's and the growth of a heavy metallurgical industry in the Ruhr in in 1850's. With excellent water and rail transportation facilities, Germany's industry was not concentrated in the heavy metallurgical centers to the degree found in Great Britain. Rather, the widely dispersed industry was able to obtain raw materials and coal by rail or water facilities. The dispersal of all but the heaviest industry has been maintained in Germany to the present. In the twentieth century this dispersal has been reinforced by the extension of electrical transmission to even the remotest villages of the Black Forest and the Vosges.

Industrial Trends

At the conclusion of World War II in 1945, Germany was divided, becoming East and West Germany. The growth of manufacturing in West Germany since 1948 is sometimes referred to as the "German economic miracle." The rise in production in the first six months after the monetary reforms of 1948 was about 46 per cent. The production index for 1949 stood at 143 per cent of the 1948 figure. The annual rates of increase between 1950 and 1960 were 26, 18, 7, 10, 12, 14, 8, 6, 3, 10, and 10 per cent. By 1951, West Germany had surpassed the United Kingdom in terms of cumulative rates of increase since 1938. By 1956 this rate of growth had surpassed that of every other country in Western Europe. Between 1950 and 1960 West Germany's industrial production increased no less than 90 per cent, the largest in Western Europe. Of the leading industrial nations only Japan and the Soviet Union have experienced a comparable growth rate.

A series of interrelated factors have made West Germany's industrial rise possible. In the early recovery period U.S. aid was important. However, evidence is lacking that American aid has been primarily responsible for the continued growth. West Germany actually received less aid than the United Kingdom or France. The replacement of industry dismantled in the early postwar years also reduced the importance of American aid. Although West Germany did not maintain a military establishment, her contribution toward the support of Allied occupation forces absorbed about as much of the national income as the defense expenditures in other European countries.

A factor of importance in the growth of West German industry has been the huge investment in research and development. In 1960 it was estimated that 40 per cent of the industrial equipment of West Germany was less than five years old, and about 60 per cent less than ten years old. Until 1965 it is estimated that at least 80 per cent of investment capital will be for equipment.

The maintenance of stable prices in West Germany has also been a fundamental part of recovery. Although prices rose sharply after the lifting of controls in 1948, the price level has been nearly constant since 1951. Few countries have been so successful in maintaining price stability. At the same time wages have risen. In the period 1950 to 1960 wages increased by more than 100 per cent while the cost of living rose by less than 25 per cent. This has caused an increase in purchasing power in the domestic market, and also created considerable capital for investment in industry. A comparison with prewar figures reveals that the real hourly wage rates in West Germany in 1960 were nearly 60 per cent higher than in 1938, while the British equivalent had increased by only one-quarter. The market for consumer durables has risen greatly in West Germany in recent years. The Office of European Economic Cooperation statistics reveal

that the real per capita private consumption between 1938 and 1960 was about 25 per cent for West Germany and only 7 per cent for the United Kingdom.

The development of sound international trade policies has greatly aided West Germany's industrialization. These include a variety of measures. Trade policies such as quick and reliable delivery dates and an established credit system have made the purchase of German goods attractive. Stable prices have also prevented the foreign exchange difficulties that have plagued many nations. This has prevented the placing of restrictions on foreign trade which have commonly been applied elsewhere.

The West German labor situation has both favorable and unfavorable aspects in the present industrial expansion. For much of the postwar period West German labor has worked at lower wages than in many other western European countries. Yet a continuous rise in wages has kept workers satisfied. From 1950 to 1960 the average wage rose from 30.3 cents per hour to 64.3 cents. Employers for the most part have managed to absorb rising wages in improved efficiency. The postwar period has been marked by almost complete industrial peace. Workers have been satisfied with growing pay, shorter hours, and increasing vacations. As the industrial output increases shortages of labor have arisen in many industries. If this should continue, the labor shortage could be a major factor in slowing the industrial expansion of West Germany. In recent years there has been a tendency for labor to shift from industries of low productivity to industries of high productivity.

Finally, governmental influence can not be disregarded in present West German industrial growth. Tax laws and government policies have been geared to encourage profits and industrial expansion. The government has promoted foreign trade by the removal of most trade barriers. Personal income taxes in Germany have a top rate of 53 per cent compared with 91 per cent in the United States; thus, personal incentives can be greater in West Germany. Corporation taxes are about the same in West Germany as in the United States, but industry gets more liberal depreciation allowances.

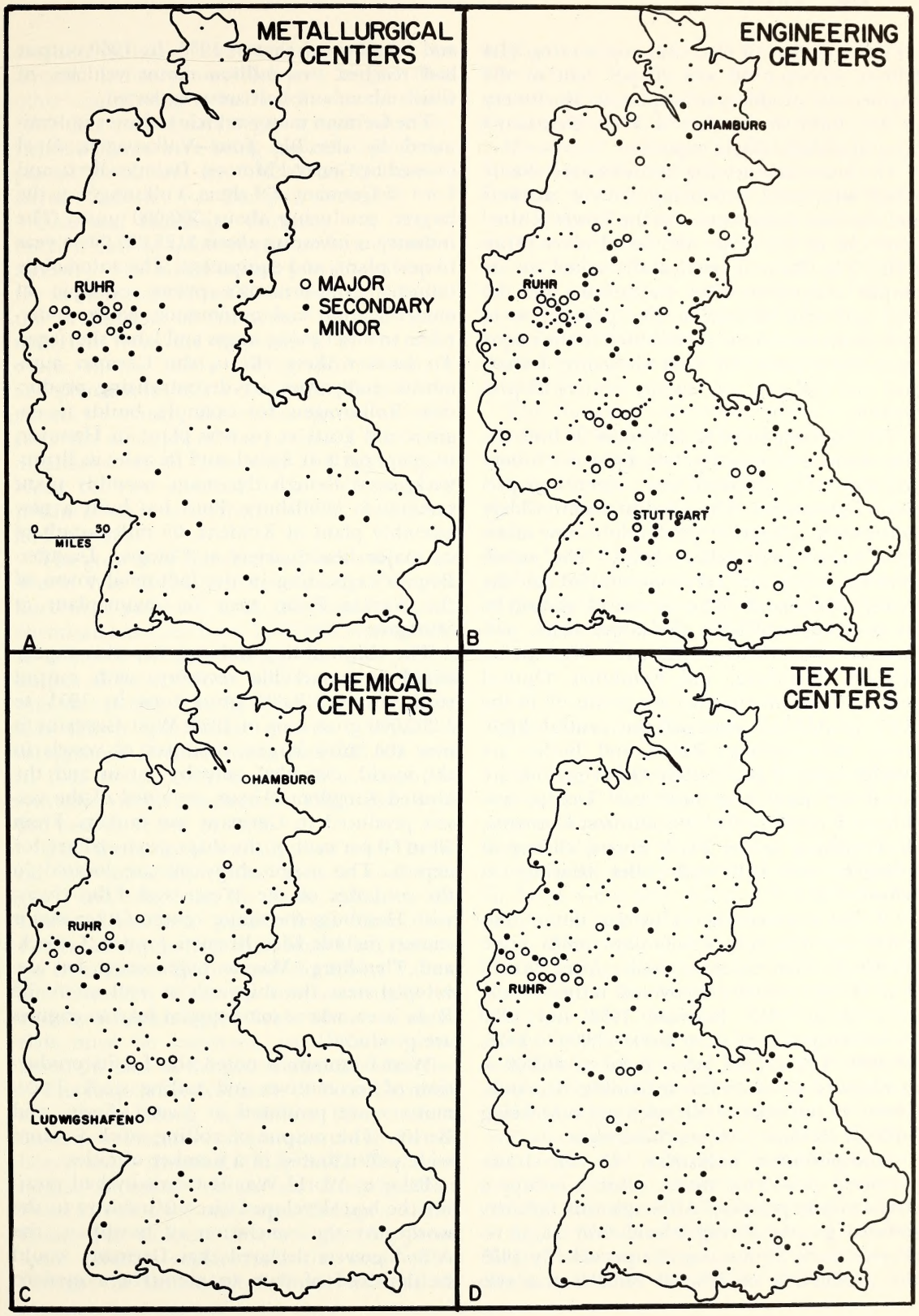
Structure of Industry

West Germany is one of the world's major industrial nations. In 1960, 7,550,000 workers were on the average employed in factories having ten or more employees. This represents about one-third of all persons employed in the Federal Republic. There are approximately 98,000 industrial concerns in operation. Of these, only 1 per cent has more than 1,000 employees, 6 per cent between 200 and 999 employees, and 48 per cent between ten and 199 employees. Forty-four per cent of all industrial firms have fewer than ten employees, although they produce only about 2 per cent of total industrial output. About 50 per cent of all industrial workers are engaged in enterprises with more than 100 employees.

In the Federal Republic the processing industries dominate production. In 1960 this segment accounted for 88 per cent of total production, apportioned as follows: basic materials and production goods, 23 per cent; capital goods, 30 per cent; consumer goods, 19 per cent; and foodstuffs and luxury goods, 16 per cent. Some 6 per cent of industrial production came from mining, 4 per cent from the generation of power, and 2 per cent from the building industries.

Of the individual industries, the greatest employment is in machinery, with 11.3 per cent of the total, followed by textiles, 8.9 per cent; electrochemical industries, 7.8 per cent; food processing, 5.7 per cent; chemicals, 5.6 per cent; motor vehicles, 4.5 per cent; and apparel, 4.4 per cent. If manufacturing is measured by net value of output, chemicals and allied products hold first place with 9.8 per cent of total industry followed by machinery, 9.3 per cent; textiles 8.9 per cent; electrochemical industry, 6.9 per cent; vehicles, 5.8 per cent; tobacco processing, 5.0 per cent; railway construction material, 4.7 per cent; and iron and steel industry, 4.0 per cent.

Engineering industries. The engineering industries have experienced a phenomenal growth since 1948. These industries now employ at least 1,500,000 workers and since 1958 have experienced critical labor shortages. The widest range of engineering products is produced. In 1960 the output of the mechanical engineering industries totaled more than $5.0



3.4. Location of Selected Industries in West Germany.

billion and that of electrical engineering $4.4 billion. Between 30 and 40 per cent of the engineering products are exported. Machinery in one form or another is West Germany's most important single export.

The heavy engineering industries are closely allied with steel producing and/or markets and are thus concentrated in the Lower Rhineland and in the major industrial cities (Map 3.4B). The Ruhr is particularly noted for its output of equipment for coal mining and the iron and steel industries. The production of agricultural machinery is oriented to the major agricultural areas. In West Germany, Düsseldorf and Cologne are leading centers of production.

The light engineering industries include the manufacture of metal goods, light machinery and apparatus, electrical equipment, and precision instruments. These industries are widely distributed, primarily in relation to raw materials, market, and labor supply. The metalworking industries are concentrated in the Lower Rhineland. The electrical industries are found primarily in the larger cities, particularly West Berlin, Stuttgart, Mannheim, Munich, Nürnberg, and Frankfurt. Optical and precision instruments are produced in the older established areas of the central highlands. Württemberg, Baden and Berlin are notable areas of production. Other regions are noted for particular products. Textile machinery is concentrated in southwest Germany, clock making in the Black Forest, cutlery at Solingen, and ball and roller bearings at Schweinfurt.

Of the engineering industries none illustrates the dynamic present-day trends more effectively than machine tools. After World War II the industry recovered rather slowly until about 1957. Between 1958 and 1960 annual output grew from $100,000,000 to $475,000,000. The skilled labor force of 86,000 is inadequate to meet the increasing demands. About 10 per cent of all machines now being built in Germany are machine tools.

Transportation industries. Of the transportation industries, motor vehicles occupy a commanding position. Although this industry suffered greatly during World War II, it recovered early in the postwar period. By 1955 the production of 908,000 vehicles was two and a half times that of 1938. By 1960 output had reached two million motor vehicles, of which about one-half were exported.

The German motor vehicle industry is dominated by the Big Four—Volkswagen, Opel (owned by General Motors), Daimler-Benz, and Ford of Germany. Of these, Volkswagen is the largest, producing about 700,000 units. The industry is investing about $125,000,000 a year in new plants and equipment. The automobile industry is Germany's prime example of modernization and automation being undertaken to offset rising wages and labor shortages. To further these efforts, the German automotive companies are decentralizing production. Volkswagen, for example, builds its engines and gears at its new plant in Hanover, its spare parts at Kassel, and its axles at Brunswick, even though the main assembly plant remains at Wolfsburg. Ford has built a new assembly plant at Koblenz, 65 miles south of its major headquarters at Cologne. Daimler-Benz is expanding in the industrial towns of the Neckar Basin near its main plant at Stuttgart.

The shipbuilding industry has also experienced a remarkable recovery, with output rising from 318,000 gross tons in 1951 to 1,202,000 gross tons in 1959. West Germany is now the third largest producer of vessels in the world, exceeded only by Japan and the United Kingdom. About one-third of the vessels produced in Germany are tankers. From 50 to 60 per cent of the ships produced are for export. The major shipyards are located in the estuaries of the Weser and Elbe rivers, with Hamburg the major center. Other major centers include Kiel, Bremen, Emden, Lübeck, and Flensburg. Marine engineering has developed near the shipyards as well as in the Ruhr area, where some special marine engines are produced.

West Germany is noted also for its production of locomotives and rolling stock. Locomotives are produced at Kassel, Essen, and Berlin. The output of rolling stock is more widely distributed in a number of cities.

Prior to World War II Germany had possibly the best developed aircraft industry in the world. At the conclusion of hostilities, the Allied powers declared that Germany would be deprived of data to maintain a modern

aviation industry. The redevelopment of the aircraft industry was delayed longer than other engineering industries. It was not until 1959 that the industry began a rapid recovery. In 1960 planes were being assembled from imported parts, and by 1962 West Germany's aircraft industry was Europe's strongest.

Chemical industry. Germany was one of the first nations to develop a modern chemical industry. The initial industry was based upon the manufacture of fertilizers from potash and the production of synthetic dyes and other materials from the by-products of the coke ovens. In the 1880's photographic materials and pharmaceuticals were added. Early in the twentieth century the extraction of nitrogen from the atmosphere was perfected. Later the distillation of oil from coal and lignite provided the raw material for a wide range of products, such as synthetic rubber, detergents and plastics.

The growth of the chemical industries since World War II has been spectacular. The production of sulphuric acid, the chief inorganic chemical, has risen from 1,703,000 tons in 1951 to 2,938,000 in 1959. During the same period, output of hydrochloric acid rose from 92,800 tons to 211,000. The fertilizer industries have also shown spectacular growth. Output of nitrogenous fertilizer rose from 538,000 tons in 1951 to 1,051,000 in 1959. The output of synthetic rubber, revived in 1951, rose from 900 tons to 48,900 in 1959.

West Germany is well supplied with chemical raw materials. These include coal tars, gases, and coke from the Ruhr, salt from the Lower Rhineland, potash from Hesse and Lower Saxony, pyrites from Sauerland, natural gas from Lower Saxony and the Rhine Valley, and electricity from the southern highlands and the Rhenish lignite fields. Some raw materials must be imported, particularly petroleum, the base of the petrochemical industries.

The major chemical areas of West Germany are aligned along the Rhine River, where water provides low-cost transportation for the heavy, bulky chemicals (Map 3.4C). The three largest chemical centers are Ludwigshafen, Frankfurt-Höchst, and, near Cologne, Leverkusen. The Cologne area is a growing petroleum refining region, and the route from Cologne to Düsseldorf is lined with alkali, sulphuric acid, rayon, plastic, and synthetic fiber plants. Within the Ruhr area chemical centers include Duisburg, Mülheim, Gelsenkirchen, Bochum, Dortmund, and Wuppertal.

Handicraft industries. The handicraft industries are still strongly represented in West German industry. Although these industries have frequently been superseded by large industrial concerns, the availability of small motors and machine tools has made it possible for the survival of handicrafts. In 1960 in West Germany, including West Berlin, there were 775,000 handicraft workshops which employed more than half as many persons as in factories.

The building industries have the greatest number of employees. Other handicraft industries include apparel, shoemaking, gold- and silversmithing, watchmaking, bookbinding, woodworking and carving, photography, and radio and television repairing. Handicraft shops have tended to grow larger. At the beginning of the century, the average number of employees was two, but it has now risen to five. At present about 600,000 apprentices are being trained by master craftsmen.

Manufacturing Regions

Although manufacturing is widely dispersed throughout West Germany, regions of concentration can be identified (Map 3.5). The Lower Rhine, with its major center in the Ruhr, is the most important industrial region in West Germany. About 2,800,000 workers are found here or nearly 40 per cent of the total. The industrial region of the Middle Rhine has approximately one million workers and that of the Neckar Basin 1,300,000. In northern West Germany, Lower Saxony has about 600,000 workers in the Osnabrück-Hanover-Brunswick Region. The Saar Region has about 300,000 industrial workers. A number of isolated centers in West Germany are major manufacturing nodes. Of these West Berlin is the largest with over 280,000 industrial workers. Other major centers include Hamburg, 225,000, Bremen, 105,000, and Munich 150,000.

Lower Rhine Industrial Region. The Lower Rhine Industrial Region, with its core in the Ruhr coal field, is not only Germany's lead-



3.5. Manufacturing Regions of Germany.

ing industrial area, but a major world manufacturing node. The heavy industry core of the Ruhr, dominated by primary metal production, is encircled to the south, west, and northwest by a group of cities where textiles, machinery, and metal fabrication are of significance. This region is a triangle with the base extending about 35 miles along the Rhine River and narrowing to a peak about 60 miles to the east at Hamm. Within this area live more than 10 million people. It has three cities nearly the size of Pittsburgh—Essen, Düsseldorf, and Dortmund—and a dozen larger than Gary, Indiana. This area mines nearly all of West Germany's bituminous coal, producing more than 90 per cent of her steel, about two-thirds of her finished and semifinished metal products and much of her chemicals, textiles, and machinery (68).

The Lower Rhine owes its development to a number of factors. Its two greatest assets are its coal resources and its crossroads position in central Europe. This area contains the largest deposit of coal in Europe, a large proportion of which is of coking quality (63). The West German production of coke comes predominately from Ruhr coal. There are also small coal deposits in the Aachen region, and lignite is found in the Cologne area. Originally the area also possessed small quantities of iron ore which fostered the initial developments; but these desposits are exhausted. The forest-

covered hills provided charcoal for smelting ores before the use of coke.

The mammoth growth of this industrial region cannot be explained entirely by the availability of local coal resources. Its locational advantage as a major crossroads of Western Europe cannot be disregarded. The north-south trending Rhine Valley provides a natural water route to the North Sea. Canals provide additional cheap transportation and also connect the Rhine with the network of waterways in western Germany. Besides water routes a major network of railroads has also been built radiating from the region.

The development of an integrated industry, aided by cartels, augmented the other advantages and gave the Ruhr its unprecedented growth. The Ruhr contrasts with most industrial regions of the world in its thorough integration. This was the first area in Europe to develop a complete vertical integration of all stages of production from the coal fields to the finished metallic or chemical products. At the same time a unity was created by horizontal integration in which all firms making a similar product coordinated their production. The efforts of the industrialists to create a strong union were encouraged by aid from the German government. For example, German transportation rates were lower for iron ore than for coal, so that French and Swedish iron ores could move more cheaply to the Ruhr, than Ruhr coal could be transported to foreign areas producing the ores.

The growth of European cartels in the early decades of the twentieth century also influenced the Ruhr advantageously. The strong industries of the Ruhr, particularly metallurgy and chemicals, gained effective control of production in other countries. The organization of industrial management into large cartels gave the Ruhr a privileged position prior to World War II. Because international production could be controlled by the Ruhr industrialists, the marketing position of the Ruhr was greatly enhanced.

The unique industrial concentration of the Ruhr made it a major target during World War II. However, the centers of the cities were bombed the heaviest. Plants, mines, and factories on the edges of cities largely escaped or were rebuilt prior to the end of hostilities. In 1945 at least 75 per cent of the industrial facilities were in operation. The notable exception was the Krupp plant, which was 80 per cent destroyed. This plant was in the center of Essen and the city had grown up around it. Since World War II the Ruhr industrial region has been completely rebuilt, and from the early 1950's it has assumed its leading position in the European industrial setting.

The Ruhr is primarily noted for its production of iron and steel and associated engineering industries. Its blast furnaces, steel converters, and rolling mills are localized on the coal fields, with each particular site being at the point of easiest assembly of raw materials. An almost continuous urban area stretches north of the Ruhr River from Duisburg-Ruhrort, the leading Rhine port, eastward to Dortmund. Within this conurbation, Essen is the "capital" city and home of the famous Krupp iron and steel empire. Other heavy metallurgical centers include Oberhausen, Mülheim, Hamborn, Haspe, and Rheinhausen.

In general, the heavy engineering industries are situated near the source of iron and steel. This region is noted particularly for the output of equipment for such basic industries as coal mining and the iron and steel industry. The heavy machine centers include Dortmund, Oberhausen, Bochum, Essen, Hagen, Cologne, Düsseldorf, and Duisburg. The region is noted for its quality machinery. The Ruhr is one of the leading centers of machine tools, with major production in Dortmund, Düsseldorf, Duisburg, Remscheid, Rheydt, Leverkusen, Cologne, and Solingen.

The Ruhr coking industry has provided the basis for a chemical industry. The heavy chemical industries—those that are concerned with the large-scale production of bulky chemical products from massive raw materials—are localized near the coke ovens. High temperature carbonization of coal produces coke or coal gas, and the coal tars are distilled further to yield both light and heavy oils. The chemical processing of these oils yields explosives, dyestuffs, pharmaceuticals, and a host of other products. Water is also consumed in tremendous quantities by these industries, and a river or canal site is usually considered essential. It is evident that a majority of the

plants are situated on the Ruhr coal field, with the specific site being determined by an available water supply. However, there are also a number of plants in the cities localized in connection with the coal gas works. Cities producing basic chemicals include Dortmund, Recklinghausen, Herne, Gelsenkirchen, Bochum, Essen, Duisburg, Leverkusen, Cologne, Aachen, Stolberg, and Castroph-Rauxel.

In the Lower Rhine, cotton textile industries were introduced in the late eighteenth and early nineteenth centuries. They were fostered by the continental blockade of the British navy during the Napoleonic wars, which stopped the importation of British goods. Cotton textiles rapidly replaced the earlier linen industry. Wuppertal has developed as the center of the industry. The Wupper River, a remarkably clean stream, determined the location of the textile mills, washeries, and dye works, and the earlier cotton textile cities of Barmen and Elberfeld were combined to create the industrial agglomeration of Wuppertal. A dye industry has been added to the earlier weaving of cloth, and Wuppertal is also a textile machinery producer. The textile towns have developed to the south and west of the heavy metallurgical centers. Because of a lesser need of fuel the textile industry is not localized on the coal field. The textile centers on the east side of the Rhine—Wuppertal, Düsseldorf, and Siegburg—are closely integrated with the textile centers on the west side, such as München-Gladbach, Rheydt, Dormagen, Krefeld, Cologne, and Aachen. The immigration of French Huguenot refugees in the seventeenth century initiated the silk industry in the west Rhine centers. They remain today because of skilled labor and the market provided by the industrial agglomeration. In addition to products already mentioned, the area's manufacturers include food processing and the production of cement, cellulose, paper, synthetic rubber, glass, and ceramics.

Middle Rhine. In the Middle Rhine area a complex industrial economy has evolved, with its traditional focus at the northern end of the Rhine Valley at Frankfurt-Mainz and Mannheim-Ludwigshafen. The Rhine corridor, providing both water and land routes, is the key to the industrial evolution of this area. The Rhine River is not only navigable throughout the industrial district, but from the North Sea to southwestern Germany. In addition the valley provides a natural route for railroads, highways, and canals. The value of this corridor is enhanced by the major tributaries of the Rhine, and their valleys provide routes which connect the Rhine Valley with the rest of West Germany. As a result each of the confluences—the Mosel, Lahn, Main, and Neckar—has become a focus of trade routes and industrial nodes.

Aside from the transportation advantages, the Middle Rhine is not particularly well-endowed with resources. An available water supply has been a major factor in the growth of the chemical industries. There are small iron ore deposits in the Sieg and Lahn valleys, as well as small deposits of copper, lead, and zinc. The only power resource in the region is provided by hydroelectric installations in the gorge area of the Rhine. The area is favorably situated, however, to receive coal from the Ruhr to the north and hydroelectric power from the German highlands to the south. There are also local food supplies and other agricultural products, upon which manufacturing has developed.

Because of limited power and raw materials in the region, the skill of the worker is the most valuable resource here. The industrial structure of the region is thus characterized as one producing quality products while using a minimum amount of raw materials. Because the area is noted for its transportational facilities, raw materials from many sources can be assembled easily, and manufacturing here is thus characterized by its diversity.

The Frankfurt-Mainz-Wiesbaden node became an industrial center about the middle of the nineteenth century. This industrial complex manufactures machine tools, machinery, motor vehicles, chemicals, leather, wood products, foods, and textiles. Mannheim is a major Rhine port and transshipment center. Having begun as a location for milling grains and producing cellulose from local timber, it is now a center for glass and ceramics, machine tools, heavy machinery, precision and optical instruments, aircraft and motor vehicles, pulp and paper, and chemicals. On the western side of the Rhine opposite Mannheim

is the chemical city of Ludwigshafen. The chemical industry of Mannheim-Ludwigshafen is noted for large-scale production of bulky chemical products such as sulphuric acid and synthetic nitrate. The raw materials are assembled by water on Rhine barges. This is the area where the company Badische Anilin-und-Soda Gesellschaft originated, which later became the nucleus of the I. G. Farben Industries. This was the largest chemical company in the world prior to World War I, and the most powerful chemical trust in Europe prior to World War II. Other diversified industrial centers of the region include Offenbach (noted for aniline dyes, machine tools and leathers), Rüsselsheim (aircraft and motor vehicles), and Darmstadt (chemicals and machinery).

Neckar Basin. The Neckar Basin, with Stuttgart as its center, is second only to the Ruhr as a major industrial region of West Germany. Originally small industrial establishments were widely scattered, primarily localized by available water power. The region possesses few natural resources to encourage manufacturing, although salt is found in abundance and a small deposit of iron ore is located southeast of Stuttgart. Hydroelectric power has been developed in the region and is also obtained from the nearby highlands of southern Germany. The handicraft industries provided the base for the growth of a large, skilled labor force, the most important industrial resource of the region today. Industrial development here is based primarily on the type of labor available rather than on raw materials.

Industry is widely dispersed throughout the region. Most of the small towns have some type of industrial establishment, and these plants are usually small. Because of the hilly nature of the region the principal industrial cities are concentrated in the Neckar River valley and its tributaries where the best transportation facilities are available.

Of the industrial cities in southwestern Germany, Stuttgart is predominant. It is the region's principal transportation junction and thus has a marked advantage for the assembly of raw materials and the distribution of finished goods. Much of the industry of Stuttgart is concentrated in such surburban centers as Bad Cannstatt, Feuerbach, Untertürkheim, and Zuffenhausen. Industry is highly diversified in the Stuttgart area. Electrical engineering is of primary importance, followed by motor vehicles and all types of machinery. Precision and optical instruments include photographic equipment, radios, and motion picture projectors. The chemical industry has greatly expanded in recent years. In contrast, the textile industry has declined considerably. Other activities include shoes, furniture, office equipment, paper, foodstuffs, and breweries. Stuttgart is widely known for its printing works and has over 200 publishing houses.

From Stuttgart, industry extends southward to Tübingen, and includes Metzingen and Reutlingen; to the east is the Fils Valley, with such centers as Esslingen, Göppingen, Eislingen, and Geislingen; and to the north in the Neckar Valley are such industrial centers as Ludwigsburg, Heilbronn, Eberbach, and Heidelberg. Most of these places are industrial miniatures of the Stuttgart area. The mechanical industries are well developed, as are the precision industries. Textile manufacturing is more widely distributed throughout the region as a whole than any other industry. Many of the smallest towns have textile plants, where water power was once the major localizing factor.

The Saar. The Saar is a small buffer state between France and Germany (64). Between 1945 and 1958 it was a part of France, but in 1958 it once again became incorporated into Germany. It has long been an important industrial node, with local resources being important in the establishment of the early industries. The manufacture of glass and ceramic products developed in the sixteenth century based on local clays, sand, and, especially, abundant wood for fuel. Later the metallurgical industries were attracted by the presence, not of coal, but of local iron ore and charcoal from the forests of the area.

Although the original resources that fostered industry are nearly gone, manufacturing has grown in importance largely from the availability of local coal and nearby supplies of Lorraine iron ore. Unfortunately, Saar coal is inadequate for producing coke for the modern blast furnace, and coking-quality coals, largely coming from the Ruhr, must be blended with Saar coal for these purposes. The specific

location of industry has been determined by accessibility to navigable waterways and fuel. As a result one industrial zone follows the valley of the Saar River, and the other lies on the coal field. Saarbrücken, the capital of Saar, lies at the junction of these two routes.

Local iron and steel provides the raw material for the metal fabrication industries and the area now is a producer of machinery and construction equipment. The chemical industries, based on raw materials obtained from the by-product coke ovens, have flourished. Other important manufacturing activities include the production of glass, pottery, mosaics, and tile.

The Saar is well situated to market its products. The major north-south road from Flanders to Italy crosses the Saar, as well as the principal land route from Lorraine to the Rhine in West Germany. The development of manufacturing has made the Saar an area of dense population. Approximately one million people live in an area of less than 1,000 square miles, assuring an adequate skilled labor supply, and at the same time a sizable local market for manufactured goods.

This industrial node is prized by both West Germany and France because of its high productivity of heavy durable goods. The Saar is also closely allied to the economy of France and West Germany, importing from both nations. Industrially, the Saar is more essential to France than to West Germany, since France has limited coal resources. However, the population of the Saar, predominately German, desires to be politically affiliated with Germany rather than France.

Osnabrück-Hanover-Brunswick. A group of industrial cities has developed along the contact zone between the northern German plains and the Central Uplands. This district is a product of Germany's major east-west transportation route. At an early date this area, with its rich loessial loamy soils, became one of Germany's most important farming districts. The location of the principal towns, in particular Münster, Osnabrück, Minden, Hanover, and Brunswick, was determined primarily at sites that afforded easy crossings of a series of north-south flowing rivers. These cities thus served as foci of east-west land routes and north-south water routes. They developed originally as commercial centers for the surrounding agricultural areas.

The demands of a large and prosperous urban and rural population, were a factor in the evolution of a manufacturing economy in the trading centers. A significant proportion of the manufacturing is devoted to the processing of the region's agricultural commodities, particularly sugar beets, vegetables, and wheat. However, the region possesses other resources that have favored the growth of industry. The lignite, potash, petroleum, and salt deposits have formed the basis of a chemical industry. The low-grade iron ore deposits, local charcoal and some coal, early fostered the growth of an iron industry. Osnabrück was a traditional center of iron and steel production, but the industry has declined. Nevertheless the present day iron and steel fabricating and light engineering industries can trace their origin to the availability of local raw materials.

The modern iron and steel industry is located in the Watenstedt-Salzgitter district. In 1937, at the time Germany was striving for national self-sufficiency, the Nazi government planned to produce 20 million tons of iron ore in the region, of which two-thirds was to be smelted locally and one-third to be sent to the Ruhr by canal in exchange for coking coal. A production of four to five million tons of steel was also envisioned. The vast project was begun in 1938 and the first blast furnace was tapped in 1939. Because of war demands output was rapidly increased and at the end of the war twelve blast furnaces had been built, of which eight were in operation, 330 coke ovens produced 2,100,000 tons of coke, and steel output was 1,100,000 tons. The rolling mill was the largest single structure in Europe. Production all but ceased after the war but a revival began in 1949, and by 1957 steel output had exceeded the World War II peak. Because of the regional market the industry has good prospects, but it must continually produce at its highest efficiency in order to compete with the fuel-oriented Ruhr Region (58).

The Watenstedt-Salzgitter heavy industry complex was developed in essentially a rural area. The industrial development has profoundly transformed the area, through the

rapid growth of blast furnaces, coke ovens, and rolling mills; the urgent need but relatively slow growth of dwellings for workers; and the problem of providing adequate services for the population, such as transportation to and from work. In 1942 the seven small cities of the district were incorporated into a single political unit.

A highly diversified manufacturing economy has evolved, characterized by the output of high value-added products. The availability of metals produced in the region plus the ease of raw material assembly from outside the area because of the excellent transportation facilities, has fostered the metal fabrication and light engineering industries. For example, Hanover is noted for the production of machinery, machine tools, electrical equipment, precision and optical instruments, and motor vehicles. Besides these products, the market of the region has been influential in the establishment of textiles and apparel, furniture, pianos, and pharmaceutical industries. Bielefeld, long known as the Westphalian linen industry center, has become known for its production of sewing machines and for light engineering industries.

One of the most interesting industrial developments has occurred at Wolfsburg. In 1937 the Nazi government selected this country village as the site of its proposed Volkswagen plant. This locality was chosen because it was along a main transportation route and at the same time near a labor-excess area in Thuringia and Saxony. The automobile plant was started prior to World War II, but before production began the war halted output of motor vehicles. During the war period the plant produced airplane parts. Since World War II production of automobiles has increased steadily and the plant has been enlarged. The Wolfsburg area has evolved as a one-industry region. The plant offers one of the highest wage scales in Germany and monopolizes the local labor market. No other industry has been able to establish itself in the area, and the economic structure of the region is dependent on automobiles and the export market. The establishment consists of one vast plant situated astride a railroad and a canal. The plant capacity is approximately 3,000 cars per day (1961). Virtually all of the cars are shipped from the plant by rail. Truck transportation has not been adequately developed to permit use of road transport.

When the Nazi government selected Wolfsburg as an industrial center a new city of 100,000 was envisioned. The initial plan of the city, grouped around a central acropolis, was abandoned after the war. Although the plan was excellent, the recent development has created a sprawling, ugly industrial settlement. Housing has not been able to keep up with the pace of rapid growth of employment and some workers commute up to 40 miles to work in the factory.

Hamburg. Hamburg is the largest single industrial city of West Germany. In the nineteenth century, with the growth of German industry, Hamburg became the leading import and export center for industrial raw materials and manufactured goods. The Elbe region was the traditional hinterland for Hamburg. Since this area is now largely controlled by the communists, Hamburg has attempted to secure more of its traffic from West Germany. With the development of land transportation routes to the west the flow of goods has greatly increased. Hamburg has thus maintained itself as a general port, with equipment for handling all kinds of traffic.

Diversified industry has developed in the city, much of it related to the port function. As measured by employment, the largest industry is shipbuilding. The Hamburg shipyards, situated on the south bank of the Elbe estuary, are the largest in Germany, launching about one-third of the nation's tonnage. A wide range of marine engineering works and foundries supply materials to the shipyards.

A second group of industries processes imported raw materials. Hamburg is one of the largest petroleum refining centers in West Germany. Other processing industries based on imports include copper smelting and refining, soap manufacturing, vegetable oil refining, fish preparation, flour milling, and rubber processing. These plants are largely situated in the dock area, but cigarette, chocolate, and pharmaceutical plants are widely scattered throughout the city.

The skilled labor force has also attracted industries in recent years. The machinery industry has greatly expanded, as well as that

of precision instruments. The consumer goods industries such as apparel and food processing are oriented to the large city market. In recent years a great many refugee firms from East Germany have settled here.

West Berlin. Prior to World War II Berlin was the single most important manufacturing center in Germany. The postwar partition of Berlin into East and West sections has handicapped the manufacturing industries. West Berlin, however, has remained an important center. Although Berlin was founded in the thirteenth century, it remained relatively small until it became the capital of Brandenburg, later a part of Prussia. As a provincial and later the national capital, Berlin became a political, intellectual, and cultural center. As a result of a large and expanding local market, a growing supply of skilled artisans, and the prestige of being located in the capital, Berlin became a major industrial focus.

A number of other factors contributed to Berlin's growth. The imperial capital organized German land transportation around itself, creating excellent access to the city through a radial pattern of roads and railroads. Berlin is also favorably situated on water routes, lying midway between the Oder and Elbe rivers. With the building of short canals, Berlin has access by water eastward to the Oder and thence to the Baltic Sea, and westward to the Elbe, which empties into the North Sea. As a result of these excellent land and water routes the assemblage of raw materials for manufacturing was greatly facilitated. Within the immediate vicinity of Berlin few industrial resources exist. The city is fortunate, however, in being close to the lignite deposits of central Germany, which help provide electrical power.

The location of industry in the West Berlin industrial complex reflects its historical development. The early industry developed within the city limits, and at present over two-thirds of the industry lies within the city. In general these establishments are small. In 1960 about 85 per cent of the establishments had fewer than 50 emloyees. In contrast, the industries established in the twentieth century are found in large plants on the city's periphery. Many of these firms have shifted from the inner city. Industrial suburbs are separated by areas of meadows, woods, and lakes, and prior to World War II were situated in relation to the railways and navigable waterways. The largest industrial complexes lie along the two rings of communication that surround the city, and along the through route of the Spree River.

West Berlin is noted for its diversified industries, in which small amounts of raw materials and power are consumed in the process of producing quality products. Electrical engineering is the most important industrial group, employing nearly 100,000 workers or 35 per cent of the total West Berlin labor force. Every possible type of electrical machinery, from minute motors to 10,000-ton dynamos, is produced in Berlin. The machinery industry is second in importance, with an employment of 43,000 workers. Major products include motor vehicles, tractors, machine tools, and light machinery. Similar to many industrial cities, West Berlin has developed a large apparel industry employing over 23,000 workers. The iron, steel, and light metals industries are also of significance, with 23,000 workers. Other industries include printing and publishing, 12,000 workers; chemicals, 10,500; precision machinery and optical goods, 6,800; textiles, 5,700; and paper and pasteboard, 5,700. West Berlin in 1960 possessed about 3.7 per cent of West Germany's industrial labor force. Its 5,510 industrial establishments constituted 5.6 per cent of the nation's total factories, producing 2.6 per cent of the value of total industrial output.

SWEDEN

Although manufacturing has occurred in Sweden for centuries, its importance in the economic structure of the nation has been limited until recent decades. As late as 1850 more than 90 per cent of the people lived on farms, and industry occupied a subordinate position. Only in the late nineteenth century did a modern industrial economy evolve. Many of the Swedish industries are based on such domestic resources as timber, iron ore and hydroelectric power, and produce for an international market.

Industrial Structure

With 850,000 manufactural workers Sweden possesses the most diversified industry in northern Europe. Although manufacturing ranges from textiles and newsprint to precision tools, emphasis is placed on the output of high-valued products. Many of Sweden's industries, such as quality steel tools and glass, have gained world-renown. Of its manufactured products only those based on the vast domestic timber resources are produced in great quantity.

Wood processing. Timber and woodworking are the most typical industries of Sweden. Forests are the country's most important resource and play a major role in its economic life. About 300,000 workers are employed in lumbering and lumber transport at the height of the winter season, and an additional 100,000 in allied processing industries. The modern timber industry began in the mid-nineteenth century with the appearance of the first steam sawmills. The first wood pulp mill was constructed in Sweden in 1857 and this industry has evolved as one of the nation's leaders. The wood pulp industry is concentrated primarily on the coast of southern Norrland and in Dalsland and Värmland. The largest centers in southern Norrland include Örnsköldsvik, Svartvik and Ostrand near Sundsvall, Iggesund near Hudiksvall, Karskar and Skutskar near Gavle. These mills are located near the mouths of rivers down which the pulpwood is floated from the Swedish highlands. In Värmland the largest center is at Skoghall near Karlstad. A shortage of raw materials is limiting expansion in these older centers, and the industry is slowly migrating to southern Sweden, where the deciduous forests are being exploited. The production of wood pulp has increased from three million tons in 1948 to 4,390,000 tons in 1959. Seventy per cent of the wood pulp is exported. Sweden supplies 10 per cent of world production and controls about 30 per cent of the international trade in wood pulp.

Closely allied to the wood pulp industry is that of paper production. Sweden is one of the world's largest producers of newsprint and other paper. Output of newsprint has risen from 297,000 tons in 1948 to 506,000 tons in 1959, and output of other papers during the same period rose from 622,000 to 1,057,000 tons. This industry is widely dispersed in central and southern Sweden, localized by accessibility to major sources of power. The largest mills for newsprint are in the Norrköping, Hallsta, Borlänge, Dalarna, and Sundsvall regions. The production of wrapping paper is largely located in west central Sweden near Lake Vaner and the Gota River, in order to export through Göteborg. Fine paper is also produced in west central Sweden.

Sweden has developed other industries based on its domestic timber resources. The nation is one of the world's largest producers of matches. The wood handicraft industries have long been practiced. However, it was only in the early twentieth century that joinery and furniture making developed as a factory industry. This industry is now noted for its quality design and high standards.

Iron and steel industry. The lake and bog iron ore deposits of Sweden were worked as early as the thirteenth century. The first metalliferous region of iron mines, furnaces, and forges developed in the Bergslag. The industry persisted over the centuries. From the middle of the eighteenth century to 1830 the production of pig iron was between 60,000 and 85,000 tons annually. Although this production would not be considered significant today, it represented at that time a large percentage of world production. The availability of timber for charcoal was the major localizing factor, and Sweden had not only huge forest reserves, but was also well situated to export its iron to the European nations.

When coke became the major fuel in blast furnaces, Sweden's relative world position declined rapidly. Nevertheless a quality steel industry has been maintained to the present day. The modern Swedish iron and steel industry has adapted itself to local conditions in a number of ways. Iron ores from central Sweden are supplemented by others from Lapland. Prior to World War I this industry consumed over five million cubic yards of wood per year. Because all coal must be imported, the need to use local fuels is important. In the electric pig iron furnace some of the charcoal is replaced by electrical energy and the charcoal consumption is only 40 to 50 per cent of that in the blast furnaces. In

the acid open-hearth furnace, which produces quality steels, producer gases made from wood or peat are used to eliminate the sulphuric impurities found in coal and coke.

Since about 1930 the use of electricity has continued to play a greater role in the Swedish iron and steel industry. Electrometallurgy, only possible if electricity is abundant and cheap, opened new opportunities for Swedish industry. Electric steel furnaces are replacing the older basic open-hearth plants. For example, the largest steel works, Domnarvet, employs 30-ton electric arc furnaces, and electrical energy is used in annealing steel. As a result of using greater and greater quantities of electricity, the iron and steel industry is increasingly oriented towards the hydroelectric power areas. One of the most important of these is the Gastrikland District. Sandrickan, near the mouth of the Dal River, is world-renowned for the excellence of its quality steel, used for the manufacture of such products as watch springs, razor blades, band saws, and similar items. The output of Swedish steel has risen steadily from 1,276,000 tons in 1948 to 2,814,000 in 1959.

Engineering industries. With the growth of the iron and steel industry in the Bergslag during the preindustrial era, many foundries were established. It was not, however, until about 1870 that modern engineering industries came into existence. The industries concentrated in the major cities of the Central Lowlands near sources of raw materials and labor as well as markets. These have grown steadily and at present employ about 225,000 workers, or about 30 per cent of the total labor force. The engineering industries provide about 25 per cent of Swedish exports.

A wide variety of engineering products is produced. One of the oldest of the engineering industries is that of locomotives and allied equipment. Rolling stock is made at Arlov outside Malmö, Falun, Kalmar, Linköping, Motala, and Tröllhattan. The plants making farm, mining, and forestry machinery and machine tools are widely distributed in the Central Lowlands. Agricultural machinery is also made in southern Sweden.

The shipbuilding industry is one of the major engineering industries, and Sweden has become one of the great shipbuilding nations of the world. The largest shipyards are at Göteborg and Malmö, with smaller centers at Uddevalla, Hälsingborg, and Landskrona. Output of vessels has increased from 352,000 gross tons in 1948 to 1,425,000 in 1959. Emphasis has been placed on the production of specialty vessels, particularly oil tankers.

The Swedish motor vehicle industry has developed essentially since 1950. Output of motor vehicles has risen from 16,700 in 1950 to 112,500 in 1959. This industry is situated at Göteborg, Södertälje south of Stockholm, and in Tröllhattan and Linköping in Östergötland. The parts industry is widely dispersed in about 100 towns of central Sweden. A number of foreign cars, including American models, are assembled in Sweden. The export of cars has become significant. At the same time Sweden imports about 60 per cent of its automobile needs, largely from West Germany and the United Kingdom.

Sweden has gained a world market for a number of quality specialty engineering products. Of these, electrical machinery, employing about 50,000 workers, is of importance. Stockholm, Vasteras, and Ludvika are principal electrical machinery and equipment centers. The ball bearings produced in Göteborg are considered the finest in the world. Swedish arms and ammunition, centered at Bofors and Finspang, have been exported for several centuries.

Manufacturing Regions

There are three industrial regions in Sweden. The lowlands of Central Sweden, extending across the country in a wide belt from Stockholm to Göteborg, form the industrial heart of the nation. The two lesser regions are Southern Sweden, centering on the Skane District, and the industrial nodes along the east coast of Norrland.

Central Sweden. Within this area industry is widely dispersed in a pattern somewhat similar to that of the Swiss Highlands. No single factor of localization has been effective in centralizing the industry in a dominant district, such as the coal region of the Ruhr or the Northeast Coast of England. The area is well-endowed with hydroelectric power and bountiful supplies of timber.

Within this area a number of manufacturing districts have evolved. Stockholm with its ring of industrial cities is the foremost manufacturing district in the country (75). This area has a considerable diversity of industry ranging from food preparation to shipbuilding. The major specialty is light mechanical and electrical engineering. An industrial zone has developed on the waterfront, where imported raw materials are processed. Industries typical of a large city include printing, publishing, and apparel.

On the west coast the Göteborg-Gota valley industrial area is most important. This is Sweden's major port and many of its industries are oriented to imported raw materials and the export market. Although there is a diversity of industry, engineering activities are dominant. There are three large shipyards, several ball bearing works, and a motor vehicle industry. Other products include textile machinery, calculating machines, oil and sugar refinery equipment, pottery, linen and cotton textiles, foodstuffs, and beer. The Gota Valley, which extends from Vaner to the Skagerrak, is noted for its pulp and paper industry. This industry is based on available water power and raw material from the Värmland forest region.

The Bergslag is one of the oldest districts for the mining of iron and copper ores in the world. It is estimated that the Falun copper deposits have yielded more than a million tons of copper, but are now primarily worked for pyrites. Originally the area was isolated, but in the eighteenth century a canal was built to the region and manufacturing was encouraged. Gradually this area became one of the leading heavy metallurgical centers of Sweden. At present the major plants are situated at Domnarvet, Bofors, and Hagfors. The area originally developed on local ore and charcoal, but now must import some ore and all of its coal requirements.

A number of industrial districts center on the cities of Central Sweden. The Jönköping-Huskvarna district is noted for its engineering industries. Eskilstuna has produced precision tools since the seventeenth century. Vasteras is Sweden's largest electrotechnical center, making motors and other electrical equipment. The city was at the southern edge of the Bergslag and soon became an assembly point for the distribution of iron and steel. Metal industries developed based on the availability of raw material supplies. Norrköping, the oldest industrial city in Sweden, is a cotton and wool textile center. This area is also noted for quality paper production. The industry was originally based on waste from the textile mills, but in recent times utilizes wood pulp as one of its raw materials. The Örebro-Kumla district specializes in shoe manufacture. Although this district has a central market position all raw materials must be imported. Karlstad is the center for a pulp and paper producing district based on local forest resources.

Southern Sweden. A number of small manufacturing centers have developed in Southern Sweden. The most important of these is situated in west Skane. The availability of small coal deposits and clay has fostered some industrial growth. In general, industry is diversified and centered in the larger cities of Malmö and Hälsingborg. The coastal position has greatly influenced industrial development. Malmö is noted for its shipbuilding and textile industries. Hälsingborg possesses a copper refinery based on imported ores from northern Norway. It is also the leading rubber products center of Sweden.

In the southern portion of the Smaland Highlands is the world famous Kosta glassworks founded in 1742. Around the city of Orrefors a number of glassworks have developed. These were based on local glass sand and, originally, charcoal from the immediate forests. These plants now produce household and artistic glassware and have secured an international market.

Norrland. The coastal cities of Norrland have developed manufacturing based on raw materials from the interior highlands and an international market. The most important and widely dispersed industry is that of pulp and paper. The development of this industry well illustrates the importance of the break-in-bulk location of the coastal cities. These cities have grown at the mouths of highland streams down which the timber and pulpwood float. The availability of local electrical power has aided the industry. The coastal cities of Norr-

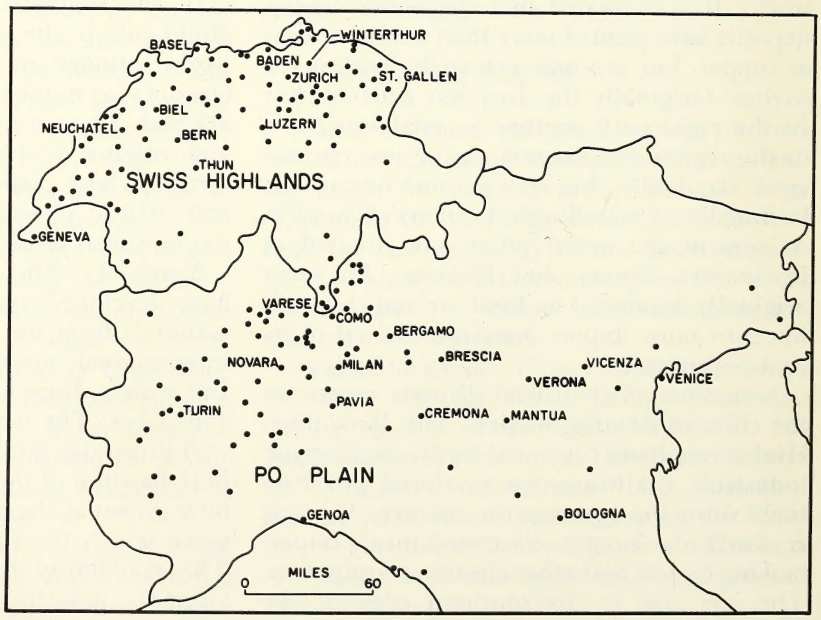
land possess about 90 per cent of the pulp and paper industry of Sweden. This industry is based almost entirely on an export market. Because the Gulf of Bothnia freezes during the winter months the pulp and paper must be stored for long periods before it can be marketed. These cities are noted for their lumber producing sawmills. In recent years there has also been the development of industries which produce other wood products such as wallboard, joinery products, and wood chemicals.

The mining industry of the region has provided a base for industrialization. The Skelleftea mining area produces copper, zinc, and lead ores that are sent to the coast for processing at the Ronnskar smelting works. Lapland iron ore is shipped to Lulea on the coast where a small ironworks has been established. The coal is brought to the area by the incoming ore vessels. The development of the iron industry is partly due to political influences as well as available resources.

SWITZERLAND

Switzerland is a manufacturing country with a world-wide reputation for excellence. Many factors have contributed to this reputation. The tradition of manufacturing is a long one, for modern industry had its origin during the Middle Ages in town and country crafts. The initial manufacturing was based on such local agricultural products as wool from the mountain sheep and flax and hemp cultivated on the plateau. Because Switzerland developed a way of life exemplifying personal freedom, manufacturing was fortified and encouraged at an early date by an influx of French, Flemish, and German refugee artisans. From the end of the eighteenth century, the Swiss textile industry was considered an example to be copied throughout the world. The democratic way of life has also encouraged manufacturing in that a landed aristocracy has not arisen, with its tendency to retard investments in new enterprises. Switzerland, as the United States, has had capital to invest in new industrial developments.

Modern Swiss industry is best characterized by its high quality and its low consumption of raw materials. Since Switzerland lacks many resources to support a modern industrial economy, the people have had to rely on two principal assets. The first is the availability of huge quantities of water power. During the twentieth century hydroelectric power has become increasingly important, and Switzerland has developed nearly 100 per cent of its



3.6. Manufacturing Regions of Switzerland and Italy.

potential. Although the largest and most spectacular hydroelectric power dams are found in the Swiss Alps, the great number of small dams on the streams of the plateau gives this region the highest development of water-power potential in the world. Because water-power sites are widely scattered, manufacturing on the Swiss Plateau is also highly dispersed.

The second and possibly most significant resource is the high industrial skill possessed by the Swiss people. Through the centuries hard work has become a cultural tradition for the Swiss worker. As a consequence, skill has been an increasingly important asset in the growth of Swiss manufacturing until today it is the most essential factor. In the Swiss watchmaking industry, labor accounts for as much as 90 per cent of the total cost while in the machinery industries it may be as much as 75 per cent.

Industrial Structure

Switzerland is primarily an industrial nation, with 46 per cent of its labor force engaged in manufacturing. Of a total of about 900,000 workers in manufacturing, 250,000 are in the machinery and apparatus industries, 135,000 in metalworking, 75,000 in watches, 40,000 in chemicals, and about 170,000 in textiles and apparel. Swiss industrial production is strongly based on international trade. Of the manufactured export products, machinery and metallurgical goods make up about 33 per cent of the total, watches 20 per cent, chemicals 17 per cent, textiles 15 per cent, and foodstuffs 6 per cent.

Of the Swiss industries, textiles are the oldest and have fostered the growth of many allied types of manufacturing. As a factory industry the making of silk cloth was introduced by Italian refugees in Zurich in the fifteenth century. Later, French refugees introduced the making of muslin in Zurich. St. Gallen, in the Alpine foothills, was an early embroidery center. At present, nearly all the branches of the textile industry are found in Switzerland. The cotton textile industry is the largest, with about 300 mills employing 30,000 people in spinning and weaving. About 30,000 tons of cotton are consumed annually in producing 165 million yards of cloth. In the woolen and worsted industries Switzerland has about 100 factories employing over 15,000 workers. There are 35 linen weaving establishments. Although the natural silk industry was established early, it experienced a steady decline until, in 1937, it disappeared completely. In its place synthetic fibers have increased greatly in importance. In the hosiery and knitwear industry, cotton, wool, and synthetic yarns are used in the machine knitting of fabrics needed for making lingerie, women's and children's clothing, socks and stockings. This is a highly diversified branch of textiles employing 15,000 persons in 150 factories of various sizes. Swiss specialty textiles include embroidery, ribbon, tapestries, and felt. Emphasis is placed on the quality rather than the quantity of textile output.

The mechanical engineering industries, emphasizing quality products, are especially well developed. The modern industry originated with the demands from the textile industry for mechanical equipment. At the same time water wheels were developed which were later utilized as turbines. Steam engines and turbines, gas turbines, and diesel engines have developed as specialties in Swiss engineering. The Swiss machine tool industry is an outstanding example of quality production. Specialties of the country are automatic lathes and precision machine tools such as are used for the manufacture of gauges, precision instruments, accurate machine components, and watches. The watch industry has encouraged the development of high-quality machine tools. Other mechanical engineering products include locomotives, machinery, and instruments.

Within recent years more than half of the output of the mechanical engineering industries has been exported. The main classes of products exported in order of their importance are textile machinery, machine tools, electrical equipment, combustion engines, steam engines and steam turbines, hydraulic machinery, typewriters, and calculating machines. The Swiss mechanical engineering industry exports its products to almost all parts of the globe.

Watchmaking is the most typical Swiss in-

dustry. In watchmaking, the ingenuity of the craftsman so thoroughly obliterates all thought of the foreign origin of the materials used, that the product fashioned in Switzerland carries only a generic name, the Swiss watch. It was in the sixteenth century, when the religious wars in France drove many Huguenot watchmakers eastward into Switzerland, that the watch industry began. Although the industry has grown in size the pride of craftsmanship and quality has remained. Over the centuries, Switzerland has developed skilled artisans and a tradition of quality workmanship that has created an undisputed superiority in the watchmaking industry of the world.

A specialized chemical industry has been developed by the Swiss. This industry began from the necessity of providing dyes for the processing of textiles. The mass production of heavy chemicals does not play an important role. The industry concentrates on the production of articles where scientific skill and quality are of importance. For example, Switzerland has won world recognition in pharmaceuticals not only for the variety of products, but for research on such items as vitamins, hormones, and alkaloids. The inorganic and electrochemical industries have attained a high level of performance in the domain of acids, alkalis, and salts.

Location of Manufacturing

Swiss industry is concentrated in the northern portion of the country on the Swiss Plateau and in the Jura Mountains. The factors of localization in this area include the availability of hydroelectric power, a large quantity of highly skilled labor, and, of major importance, a dense transportation network giving access to all parts of the region as well as foreign countries.

Although industry as a whole is widely dispersed, the individual industries show some degree of concentration. Mechanical engineering activity is localized to a large degree in the north. Zurich, the center of the industry, is noted for its textile machinery, turbines and other electrical equipment, and machine tools. Winterthur produces locomotives, diesel engines, and electrical equipment. Neuhausen is a center for railroad rolling stock and Zug produces electrical equipment. A series of towns, dominated by metalworking, extends northward from Geneva along the edge of the Jura Mountains.

The watchmaking industry is concentrated in western Switzerland. Geneva developed an early goldsmithing industry and the natural affinity of this trade to watchmaking resulted in this city becoming the first major watchmaking center of Europe. The watchmaking art spread northward into the Jura Mountains and is now implanted in the Cantons of Geneva, Vaud, Neuchâtel, Bern, Solothurn, and Basel. Outliers of watchmaking are also found in the Cantons of Schaffhausen and Ticino. In many of these areas watchmaking absorbs a considerable part of the available labor: 55 per cent of the working population of Neuchâtel, 21 per cent of Solothurn and Bern, and 11 per cent in Vaud, Geneva, and Basel. The watchmaking industry remains decentralized, with no large factories or dominant centers. There are few plants with more than several hundred workers, so that each individual is inbred with a personal as well as a "team" pride of craftsmanship.

The textile industry is widely scattered in northern Switzerland, with Zurich and St. Gallen being centers of concentration. However, scores of small towns possess a single textile factory, usually specializing in a particular branch of the industry. The industry originally localized along the small plateau streams, taking advantage of the water-power sites. Although the industry has converted to hydroelectric power, the original sites persist.

The chemical industry is fairly widely distributed, with a concentration at Basel. This center is noted for its aniline dyes and pharmaceuticals. Nearly all of the chemical raw materials must be imported, many of them coming from Germany by barge down the Rhine River. Consequently Basel, the major river port of Switzerland, has developed as the nation's chemical center. Pharmaceuticals are also produced at Zofingen, Bern, and Schaffhausen. The inorganic and electrochemical industries are more widely distributed, factories having been built in localities where the generation of low-cost electricity was available.

AUSTRIA

Manufacturing has become increasingly important in the economic structure of Austria. Since World War II the rise in the number of industrial workers is proportionate to the decline of workers engaged in agriculture. Austria has achieved a prosperity never equalled in the First Republic (1918-1938). In 1960 industrial production was about three times that of 1937. Manufacturing alone accounts for about 30 per cent of the gross national income.

Industrial Structure

The industrial structure of Austria has been greatly altered since 1940. The most significant change has been the diversification of manufacturing. Prior to World War II, textiles, food processing, woodworking, and other consumer goods dominated production. Since then manufacturing has become highly diversified. Of a labor force in manufacturing of approximately 850,000, about 27 per cent are in metal fabrication and engineering industries, 15 per cent in textiles, 10 per cent in metallurgical industries, 8 per cent in chemicals, and 8 per cent in lumber and paper industries. Other important branches of manufacturing include glassmaking, leather, food processing, and beverages.

Of the metallurgical industries, the growth of the iron and steel industry has been significant. Output of steel from 1948 to 1959 rose from 648,000 to 2,512,000 tons. The iron and steel output, 98 per cent of which is produced by the nationalized sector of the industry, exceeds domestic requirements. In the nonferrous metal industries growth has been spectacular. Of these industries aluminum has made the greatest gains, with production rising from 13,400 tons in 1948 to 85,200 tons in 1959. The metal fabricating and engineering industries have undergone similar trends.

The consumer durables and soft goods industries, while not keeping pace with the national average growth, have made some progress. The textile industry has made rapid strides in the utilization of synthetic fibers. This has been possible because of the growth of the chemical industries. Woodworking and papermaking, based on the nation's rich forest resources, have developed as major export industries. The output of wood pulp has risen from 258,000 tons in 1948 to 660,000 in 1959, and in the same period newsprint production increased from 64,000 to 137,000 tons.

Locational Trends

Prior to World War II most of the manufacturing was concentrated in the Vienna area. This was one of the traditional centers supplying manufactured goods to the Austro-Hungarian Empire. The area's industry in the nineteenth century focused on the production of luxury products such as fashionable clothes, fine furniture, musical instruments, and other items for a wealthy market. During the First Republic the production of these items declined, and was replaced primarily by consumer goods such as textiles and foods. In the period from 1918 to 1938 the Austrian economy was not sufficiently dynamic to develop significant new industrial areas.

Since 1938 there has been considerable reorientation of Austria's economic life, with the rise of new industrial areas. When the Germans invaded Austria, their goals were to increase the country's war potential and to orient the economic life of the nation toward Germany. This objective was achieved primarily by the expansion of industrial output in northwestern Austria.

An industrial zone evolved in the triangle formed by Linz, Wels, and Steyr. Within the area, Linz, the major city and transportation hub in northwestern Austria, became the leading industrial city. Manufacturing is dominated by the large iron and steel industry and associated rolling mills, coking ovens, and chemical plants. The iron and steel industry developed at the point of greatest transportation advantage in the assembly of iron ore from the massive reserves at Eisenerz and coking coal from Germany, and the distribution of the finished steel to the Austrian and foreign markets. The chemical industry of the region utilizes by-products from the coke ovens as well as the area's vast hydroelectric power resources. Linz possesses one of the largest nitrate plants in Europe. As a response to the availability of industrial raw

materials, the growth of the metal fabricating and engineering industries was stimulated. Linz has developed as a machinery center, and has shipyards as well. Wels produces farm machinery and implements and Steyr manufactures tractors, diesel engines, motor vehicles, ball bearings, machinery, and farm equipment.

Industry developed in other centers of the northwest during World War II. Of importance was the construction of an aluminum plant at Braunau on the Inn River in 1941. The plant was localized by the availability of low-cost electricity and the accessibility of Hungarian bauxite by the Danube River route. This plant was planned to provide a large share of the aluminum needs of German-dominated Eastern Europe. It now produces between 80 and 85 per cent of the total Austrian production of crude aluminum. During World War II the chemical industry in the Salzburg area received considerable impetus. Based on local salt deposits, the chemical industry produces a variety of alkalis and acids.

Since World War II the newly established regions have continued to flourish. At the conclusion of hostilities, and until 1955, the country was occupied. During this period the United States, France, and the United Kingdom occupied zones in the western and central part of the nation. In these areas there were immediate efforts to revitalize the economy. American aid, largely through Marshall Plan funds totaling $1.68 billion dollars, was instrumental in rebuilding the economy of the Allied zones. New factories were built and old centers modernized. For example the steel and heavy machinery centers of Eisenerz and Graz were enlarged and modernized. Industrialization spread to the alpine region. In the Inn Valley of the Tirol modern industrial plants specializing in the production of light machinery, aluminum fabrication, and pharmaceuticals were built. In the Klagenfurt Basin local raw materials were utilized to foster the pulp, paper, leather, and light metal industries.

In contrast to the rapid recovery of central and western Austria, industry in eastern Austria under the administration of the Soviet Union deteriorated greatly from 1946 to 1955. Many of the plants were dismantled and shipped to the U.S.S.R. After the peace treaty and the departure of Soviet occupation forces, a huge investment and tremendous effort were required to rebuild the ravaged industrial economy. Nevertheless, progress was remarkably rapid and Vienna has re-emerged as a major industrial region. At present about half of Austria's manufacturing is concentrated within the Vienna Basin. This area is recognized for its output of machinery, electrical equipment, chemicals, furniture, jewelry, and foods. The orientation of many industries to the available skilled labor and large market is indisputable.

ITALY

Modern industry came late to Italy. At the time of the unification in 1861 the nation had an economy that was overwhelmingly agricultural. By the latter part of the nineteenth century, consumer goods industries, particularly textiles, had become established in the north (79). Genoa, Turin, and Milan were evolving as industrial centers.

In the period from 1900 to World War II considerable industrial progress was achieved. The output of manufacturing industries increased by at least three and a half times. Much of the growth was in heavy industries rather than consumer goods. Engineering industries that had formerly concentrated on supplies for the government began to manufacture a wide range of products. The chemical industry, in connection with agriculture, expanded the production of fertilizers. Production of electric power increased from less than one billion to 3,100,000,000 kilowatt-hours. Iron production increased to over one million tons, and the merchant fleet grew from a gross tonnage of less than 800 thousand to more than 3.4 million tons.

The damage to the productive system of Italy was extremely severe in World War II. The national wealth was reduced by more than one-third through destruction, looting, and other effects. The gross tonnage of the merchant fleet declined to little more than 400,000 gross tons. At least 20 per cent of the factories and industrial plants were destroyed or severely damaged.

In the postwar period rapid reconstruction

was delayed, but since 1948 economic expansion has been at an unparalleled pace. In the 1950's long range goals were established to increase the effectiveness of the Italian economy. These programs covered public works, housing, and land reforms as well as industrial expansion. The relative importance of the traditional textile and foodstuffs industries continues to diminish with the expansion of the chemical, metallurgical, and engineering fields. Between 1950 and 1960 the average annual rate of industrial growth was 9.12 per cent. If the industrial output for 1953 is set at 100, food production in 1960 stood at 139, textiles 127, chemicals 246, metallurgical products 229, and engineering products 164. Although industrialization came late to Italy the nation is rapidly advancing toward the standard of a typical industrial economy.

Industrial Structure

Italy has become one of the leading manufacturing nations of Europe. In 1960 about 3,500,000 workers were employed in factories, or about 30 per cent of the working force. The number of persons engaged in industry varies greatly from region to region. In Lombardy about 48 per cent of the workers are in manufacturing while only about 5 per cent are so employed in Sardinia. The engineering industries are most important with over one million workers, followed by textiles with 600,000 employees, apparel over 400,000, food processing 360,000, wood industries 300,000, and chemicals 220,000.

Metallurgical industries. The paucity of fuel and iron ore has severely handicapped the development of the iron and steel industry. Prior to World War II when the national production totaled about 2,300,000 tons of steel, about two-thirds of the nation's needs were imported. During World War II the industry was severely damaged. As a result there has been a fundamental reorganization of the industry under the so-called Sinigaglia plan, whereby dependence on scrap has been reduced and a greater emphasis has been placed on expanding the blast furnace capacity. Because raw materials are largely assembled from overseas foreign sources, the coastal sites of Bagnoli, Piombino, and Cornigliano have expanded most rapidly. The smaller steel centers at Turin, Monza, Bergamo, Brescia, Terni, Aosta, and Trieste are heavily dependent upon domestic scrap. Production of pig iron has risen from 526,000 tons in 1948 to 2,190,000 in 1959. Steel output in the same period rose from 2,125,000 tons to 6,760,000.

Aluminum, based on Italian bauxite, is the only metal produced in excess in Italy. Prior to World War II the maximum output was 34,000 tons in 1939, about 5 per cent of the world's total. Output in the postwar period has increased from 32,600 tons in 1948 to 75,000 in 1959. Because Italy lost most of her bauxite deposits to Yugoslavia at the conclusion of World War II, expansion of the industry has been retarded. The chief smelting centers are at Porto Marghera, Bolzano, and Mori.

Engineering industries. Prior to World War II only a few types of engineering industries had developed. These included the making of motor vehicles, ships, armaments and electrical machinery. The motor vehicle industry was based largely on an export market. The other engineering industries were primarily supported by the government in response to the national defense program.

Although the engineering industries suffered greatly in World War II, they have experienced a remarkable recovery. In World War II Italy lost three-fourths of its merchant fleet. In order to rebuild the merchant marine the shipyards were among the first to be redeveloped in the postwar period. The output of vessels increased from 112,000 gross tons in 1948 to 518,000 in 1959. The shipbuilding industry is located chiefly at Genoa and Trieste, and to a lesser extent at Naples, Castellammare, La Spezia, and Venice.

The heavy engineering industries continue to be localized on the Ligurian coast and in Lombardy and Piedmont. The Genoa area is noted for its marine engines, machine tools, and other steel processing machinery. Milan and Genoa produce electrical machinery. Locomotives and rolling stock factories are found at Turin, Pistoia, Bolzano, Pozzuoli, and Milan.

The motor vehicle industry of Italy is well developed. It employs over 120,000 workers and in 1960 produced 596,000 vehicles. Italy

ranks fourth in production in Europe, after West Germany, United Kingdom, and France. The industry is concentrated in Turin, where the large Fiat plant is located, as well as the Lancia company. The remainder of the industry is found in Milan, Modena, and Brescia which have the Alfa Romeo, Maserati, and Ferrari companies.

In the 1950's the growth of light engineering industries has been conspicuous. The Italian firms are recognized for their advanced design and craftsmanship, in which labor is lavished on a product utilizing a minimum of raw materials. Output of sewing machines increased from 442,000 units to 483,000 between 1955 and 1960; during the same period the production of typewriters rose from 280,000 to 506,000, and calculating machines from 132,000 to 417,000. The motor scooter has become a major industry in recent years.

A number of centers are noted for particular engineering industries. Motorcycles and scooters are made at Milan, Mandello del Lario near Como, Lambrate, and Pontedera. Optical and scientific instruments are largely produced at Turin and Florence. Villar Perosa is noted for ball bearings and calculating machines. Machine tool factories are found in Milan, Turin, and Brescia. Milan and Pavia are dominant in the output of sewing machines. Although there are attempts to develop light engineering in the South it remains localized in the North.

Textile industries. The textile industries have been important in the Italian economy for centuries. These activities initiated the modern industrial economy of Italy and still hold an important place in manufacturing. The silk industry was once first in importance but has declined greatly since World War I. The output of raw silk decreased by one-half between 1920 and 1929. The competition from Japan and from synthetic fibers has caused the gradual demise of the silk industry in spite of a government subsidy. There are fewer than 60,000 workers in silk, largely concentrated near Milan in an area extending from Varese through Como to Treviglio.

The cotton textile industry is most important, with about 200,000 workers. Nevertheless, this branch of textiles is undergoing a period of economic stress similar to that in most other countries. Although the number of spindles has declined from 5,475,000 in 1948 to 4,854,000 in 1959, the output of cotton yarn and cloth has remained virtually stable. The raw materials for the cotton industry must be imported, coming primarily from the United States and India. The industry remains concentrated in the North in Lombardy and Piedmont, although lesser centers exist at Pisa in Tuscany and at Naples in the South. The future of the industry depends to a large degree on expansion of the domestic market, particularly in the South.

In contrast to the stagnation in the cotton textile industry, the synthetic texile industries have experienced considerable growth. Prior to World War II Italy was a major producer of rayon. After a short decline during the war, the output of rayon and acetate staple has risen from 17,900 tons in 1948 to 81,500 in 1959. This industry is based on cellulose, of which about 70 per cent of the raw materials (wood and cane) are produced domestically. The industry is concentrated in Lombardy and Piedmont. About one-half of the synthetic fibers produced are exported, making them the leading textile export.

The woolen industry is only about half as large as that of cotton. Almost every variety of woolen cloth is produced, ranging from knit goods to worsteds. In the postwar period the industry has been modernized and is efficient. By specializing in high-quality fashion goods of imaginative design, a large part of which are exported, the woolen industry has adjusted to changing conditions more successfully than either cotton or silk. The number of spindles has risen from 1,200,000 in 1938 to more than 1,500,000 in 1960. Although the industry remains rather widely distributed, the centers of Biella in the Piedmont and Prato in Tuscany have emerged as leaders.

Chemical industries. The development of the chemical industry has been influenced by the abundance of hydroelectric power and the availability of certain domestic raw materials. Of these, sulphur from Sicily and Emilia is most important, but other raw materials include salt, borax, pyrites, gypsum, fluorite, and steatite. The discovery of natural gas in large quantities in the Po Plain in 1945 has provided the base for a variety of synthetic

products of which synthetic rubber is of importance.

The chemical industry has made remarkable progress since World War II. The need for artificial fertilizers in order to increase agricultural output has spurred the growth of these industries. The increase in nitrate production from 163,000 tons in 1948 to 590,000 in 1959 illustrates present-day trends. The nitrate industry is widely dispersed in the North reflecting the localizing influence of hydroelectric and natural gas power sources as well as the market provided by the highly productive agriculture of the Po Plain. The phosphate fertilizers are also well developed, with output rising from 1,225,000 tons in 1948 to 1,794,000 in 1959. Because the production of phosphates is based on imported phosphates and domestically produced sulphuric acid, the industry is oriented to a coastal location, primarily in Liguria.

The basic chemicals are also expanding. The output of sulphuric acid increased from 975,000 tons in 1948 to 3,321,000 in 1960. The leading centers of the industry are Porto Empedocle in Sicily, based on local sulphur, and Portiglione in Tuscany, based on local pyrites. The rapid increase in output in plastics, synthetic fibers, and pharmaceuticals has been a notable feature of the Italian chemical industry.

Of the chemical industries none has had a more spectacular expansion than that of petroleum refining. The processing of petroleum has increased from 1,604,000 metric tons in 1938 to 17,533,000 in 1955, and 30,867,000 in 1960. The major refining centers are located on the Ligurian coast at Savona and Genoa, at Livorno in Tuscany, at Venice in Veneto, and at Naples in Campania. Because Italy has little domestic oil production, the crude petroleum must be imported primarily from the Middle East. The coastal refineries are oriented to serve a particular hinterland.

Manufacturing Regions

Manufacturing in Italy is concentrated in the northwest (83). The provinces of Lombardy and Piedmont possess about two-thirds of all manufacturing and, if Liguria is added, the total reaches three-fourths. In Italy as a whole the average number of workers engaged in manufacturing is about 74 persons per 1,000 inhabitants; this number rises to 100 in Liguria, more than double the Italian average in Piedmont (157), and higher still in Lombardy (173).

Outside of these three provinces, industry attains only modest proportions. In northeastern Italy, Venice and Trieste have developed certain types of manufacturing. Nodes of industry have developed in Tuscany, and Rome has a number of industries. In recent years the development of industry in southern Italy has received considerable attention. Although new industry in this region is being aided by both private and governmental funds, a major industrial region has not yet evolved in the South. Naples remains the largest industrial center in the South.

Lombardy and Piedmont. The provinces of Lombardy and Piedmont were the first areas of modern industrialization in Italy. However, as late as the 1860's the area still had a predominately rural economy. Not only silkworm breeding and silk reeling, but also cotton weaving were closely linked with agriculture. And even the mining and ironworking industries, located in some valleys around Brescia and Bergamo, were still predominately of a rural nature.

The textile industries were first to develop. By 1870 silk spinning and weaving and the wool industries were well established, and the spinning and weaving of cotton and flax were being introduced. The engineering industries were also being developed. In the period from 1870 to 1914, the improvement in the Italian financial situation, the trade treaties with other European countries, the resumption of public works, the better transportation facilities over the Alps, the increased needs of agriculture and, particularly, the expansion of hydroelectric power facilities—all gave impetus to the industrialization of Lombardy and Piedmont (80). During World War I this region was called upon to provide for the needs of the army and civilian populations. Since World War I the industry of Lombardy and Piedmont has been best able to adjust to new economic conditions.

Location of industry. Within the plains no single factor has been effective in localiz-

ing an industry in a particular district. The absence of coal and most raw materials encouraged the dispersal of industrial development. Because most raw materials had to be assembled from outside the region, centers of transportation became of great importance in localizing manufacturing. This trend was reinforced when large-scale hydroelectric power exploitation began in the Alps at the end of the nineteenth century. This power was readily brought to the existing centers of industry.

In the twentieth century the dependence on hydroelectric power and the advantages derived from a skilled labor force, have shaped the industrial character of the region. Because raw materials and solid fuels are scarce they must be used sparingly. Within recent years the availability of natural gas from the southern Po fields has increased the power potential of the region, but has not changed the traditional industrial pattern.

The two major industrial centers of the Po Plain are Milan and Turin. Of these, Milan is dominant, largely because it occupies a superior transportation position situated on the direct route to Central Europe by the Simplon Tunnel, has a skilled and large labor force, and possesses an enterprising management. Milan is noted for its industrial diversity. It is a major center, including not only the long-established silk industry, but also cotton, wool, rayon and other synthetic fibers. Many of the textile mills are located in neighboring towns rather than within the city proper. Of the wide variety of engineering industries, the important groups include motor vehicles, electrical machinery, aircraft, diesel engines, munitions, locomotives, agricultural machinery, and machine tools. The largest iron and steel plant of the Po Plain is located at Monza, and Bovisa has a large chemical plant.

The industry of Turin is dominated by the Fiat organization, which produces motor vehicles, aircraft, machine tools, locomotives, and tractors. Turin is the largest single motor vehicle center in Italy. Other industries include chemicals, textiles, steel, and electrical goods.

Other industrial towns in the western Po Plain are largely located on its periphery at the exits of mountain passes leading to both the Alps and Apennines. Many of the towns maintain a regional specialty. Pavia is the center for manufacturing sewing machines. Brescia has metal fabrication plants. Cremona is noted for its musical instruments, and oil refining has become important in recent years. Varese and Como are textile towns, the latter specializing in artificial silks.

Industries. The engineering industries employ the greatest number in manufacturing in Lombardy and Piedmont. Of a total of more than 750,000 workers in Italy about 500,000 are found in Lombardy, where a diversity of engineering products is produced. The Piedmont engineering industry is dominated by motor vehicle production. In the early 1900's the Italian motor vehicle industry consisted of about 60 companies of which one-third were located in Turin. Gradually the Fiat corporation assumed leadership, making Turin the "Detroit" of Italy (83).

Fiat is now one of the largest companies in Italy. It uses about one-third of all the power consumed in Piedmont. It builds the machinery needed in its factories and has controlling interests in some of the large petroleum companies in Italy. It controls two shipping lines for marketing its products throughout the world. Fiat has 25 branches in Italy and at least 30 in foreign countries. In recent years this single company has produced about 350,000 motor vehicles, 16,000 tractors, over 70,000 spare parts, and over 650,000 tons of steel, as well as other machinery, including diesel engines for ships.

Lombardy and Piedmont also dominate the textile industries. Lombardy with about 300,000 workers possesses about half the Italian total. The cotton industry is the most important of the Lombardic textile industries. It has more than half the spindles and about three-quarters of the looms in Italy. This industry is centered in a number of districts. In the city of Milan and to the northwest to the Swiss border there is not a single town of importance that does not possess a cotton mill, and Busto Arsizio, Gallarate, and Legnano have many mills.

To the north of Milan, mills are particularly numerous in the Monza-Cantù-Brivio triangle. They are also found to the west along the road that leads from Arcore to Anzano and to the east between Sesto and Vaprio.

From Bergamo, which is also a large cotton center, the cotton industry moves up the Serio Valley. Most of the Lombardic hosiery factories are to be found at Brescia. Como, Lecco, Cremona, Mantua, Treviglio, and Caravaggio are isolated cotton centers.

In the Piedmont the cotton industry employs about 75,000 workers, producing about 20 per cent of Italy's cotton products. The industry is not widely distributed. It chiefly employs women workers, the cotton mills having begun in localities where heavy industry had absorbed the male workers, such as the Turin vicinity, and in the Lanzo and Susa valleys.

In contrast to the dominance of cotton textiles in Lombardy, the Piedmont possesses about half of Italy's woolen mills. The bulk of the Piedmont wool industry is still concentrated in the Biella area, where large and small mills are found in the valleys of the Elvo, Cervo, Strona, Sessera, and Sesia rivers. Although the industry was originally based on local wool, only foreign wools are now processed. The wool industry has been localized by the skilled manpower in its former location on the lower slopes of the Alps along the valley paths which the flocks followed when going to their summer pastures, and where the plentiful supply of water not only washed the fleece but also provided power for the mills.

Other industries are also important in the diversified industrial structure of the region. The apparel industry is of major importance. Food processing is well developed. Sugar refineries are particularly important in Lombardy. The manufacture of jams, preserves, candies, sauces, and tomato concentrates is important in Milan. Other industries in the region include paper, leather, rubber, and chemicals.

Liguria. Although Liguria possesses only about 5 per cent of the employment in manufacturing in Italy, about 10 per cent of the capital investment in industry is found here. The industry is concentrated in the port cities, and Genoa, with its excellent harbor, holds a dominant position. Lesser industrial ports include Savona and La Spezia. Genoa developed primarily as a trade center, with industrial growth being delayed until after the middle of the nineteenth century. This growth was implemented by a number of factors. Trade treaties with the newly created Sardinian states increased the markets for Genoa's industrial products. At the same time the railway network was developing, opening the hinterland of the port to its industrial products. The locomotive and railway equipment factories built at Sampierdarena are still among the largest in Italy. Lastly the development of the Italian navy and merchant marine led to the establishment of a modern shipbuilding. industry.

About half the workers are employed in metalworking and engineering industries. Although the ferrous metallurgical industries are handicapped by the poverty of coal and iron ore, the presence of good harbors at Genoa, Savona, and La Spezia has made the assemblage of coal, iron ore and scrap relatively easy. Also, the region's deep-rooted shipping tradition and the abundance of skilled manpower have favored the establishment of the industry. The larger portion of the Ligurian steel industry is located in Genoa. The Cornigliano plant has 6,000 workers and is completely integrated. The plant is being enlarged and by 1964 will have an annual capacity of 1,500,000 tons of iron and two million tons of steel. Government subsidy is necessary to maintain the industry. Smaller steel works are found at Savona, La Spezia, Vado Ligure, and Lerici.

Of the engineering industries, shipbuilding holds a commanding position. About one-third of Italy's shipbuilding employees are located in Liguria. The tradition of shipbuilding is very old and in the nineteenth century the shipyards enjoyed world-renown. Until about 1850 the shipyards produced about 100,000 gross tons of wooden ships annually. With the introduction of iron vessels the shipyards declined. Recovery was slow, and by 1900 the annual capacity of the Ligurian yards was but 30,000 gross tons. After 1900 the government began subsidizing about 20 per cent of the cost of the vessels. The industry grew considerably until the depression of the 1930's. With the decline in demand the industry's capacity was greatly reduced. At the beginning of World War II four groups emerged as major producers. The Ansaldo group had shipyards at Sestri Ponente and Voltri; the Odero group

owned the Muggiano shipyards; the Tirreno group had shipyards at Riva Trigoso near Sestri Levante; and the Mediterraneo group was at Pietra Ligure near Savona. World War II destroyed most of the shipyards and the Italian merchant marine. In order to rebuild the merchant fleet the shipyards have been reconstructed at almost their exact prewar location. Although shipbuilding eclipses other engineering industries, a number have developed that have now attained national importance. These include the manufacture of automobile bodies, airplane motors, and refrigerators.

The food processing industries have thrived in the region. Most of these industries have developed because of a coastal location where raw materials are unloaded for processsing. The large edible-oil industry is based on the refining of olive oil imported from olive growing regions. About 80 years ago a sugar refinery was built at Sampierdarena for refining foreign cane sugar. A number of ancillary industries developed in the area. These include a distillery, a yeast factory, and a jute mill, the jute being brought in by the same ships that unloaded raw sugar cane from the Indies. The Sampierdarena refinery is still important, employing 1,000 workers and producing one-sixth of Italy's sugar.

Chemical processing is becoming increasingly important. Genoa produces about one-quarter of Italy's soap output. Petroleum refineries are located at a number of centers. At Ferranio, near Savona, is a large installation employing more than 4,000 workers and manufacturing photographic equipment that ranks among the finest in the world.

Veneto and Emilia. Northeastern Italy is an area of modest industrial development. Although the eastern portion of the Po Plain has a large potential labor supply and an accessible coastal position, the land transportational advantages are fewer. The largest industrial concentrations are found in the coastal cities of Venice and Trieste.

Venice developed as a commercial city. Only in recent years has manufacturing played an important role in its economy. The heavy industry of the city is represented by foundries, an arsenal, and shipyards. A number of the older handicraft industries have been modernized such as glass, textiles, and jewelry, and are supported primarily by the tourist trade. In the suburban area of Venice the cities of Mestre and Porto Marghera are highly industrialized. These towns are noted for the production of steel, zinc, aluminum, and ferrosilicons. The chemical industries are also established, producing fertilizers and paints. The petroleum refining industry is one of the most rapidly expanding industries.

Trieste, like Venice, developed as a commercial port. After World War I when Trieste was transferred to Italy, the old transit trade which it enjoyed as a port of the Austro-Hungarian Empire greatly declined. To offset this dwindling trade Italy encouraged the development of industry. Steel works, shipbuilding plants, and engineering factories were established as well as petroleum refineries, pulp and paper works, distilleries, and food processing plants. Almost all industry was based on imported raw materials. During World War II the industrial facilities of the area were heavily damaged, and at the conclusion of the war allied troops occupied the area, departing in 1954. However, the occupation authorities continued the prewar policy of subsidizing industry. Trieste's manufacturing has been considerably enlarged since 1945. Light engineering industries now play an important role in the industrial economy of the area. The availability of skilled labor is an important factor in attracting new industries to the area.

Outside of the two leading industrial centers, manufacturing is closely allied to the agricultural pursuits of the region. The wool and silk industries are traditional. The wool industry is particularly widespread in the northern portion of Veneto, situated at the outlets to the plain from the uplands where the flocks returning from the mountains gathered. Although the production of sheep has declined, the ease of reaching the port of Venice and the large amount of cheap, expert labor continues to keep the industry in its original location. Schio, Valdagno, Piovene, Thiene, and others are still important wool centers in the Vicenza area. Almost all are situated on the first steep shelf of the uplands, in practically the same situation as the Biella area in the Piedmont.

The silk industry still occupies a considerable number of workers in the region. Because the processing of silk usually stops at the reeling and spinning of cocoons, most of which are raised here, the continuance of this industry confirms the agricultural character of the region. Veneto remains the largest producer of cocoons in Italy, and the region has been less affected by the general decline in silk because it possesses the most favorable physical and economic conditions for breeding and the first stages of manufacture.

The food processing industries are also closely related to the agriculture of the region. The sugar refining industry, based on local sugar beets, assumes the character of a large industry through the need for large capital investments and the complexity of the processing technique. The fruit and vegetable processing, particularly tomatoes, is fairly widely distributed. There is also the processing of pork and cheese, particularly in the Modena and Reggio areas.

Tuscany. The industrial capacity of Tuscany surpasses that of Veneto and Emilia to the north and has more manufacturing than any other region in central and southern Italy. The industrial tradition of Tuscany is ancient, as this area was recognized in the Middle Ages for its artistic crafts.

Tuscany's textile industry obtained its greatest importance in Italy during the Middle Ages. With the growth of textile industries in northern Italy, the weaving mills of Tuscany have not been able to recover from several centuries of decline. No doubt the number of workers and quantity of output are no larger than they were five or six centuries ago.

The textile industry of Tuscany now employs about 40,000 workers, about 6 per cent of the textile workers in Italy. However, the capital investment in textiles in Tuscany is only about one per cent of the Italian total. The textiles are dominated by the wool sector of the industry, located principally in and around Prato. However, there are few complete woolen mills in the area. The carded wool is largely obtained from about 5,000 home looms, widely distributed over the Tuscany countryside. During the decline of the wool textile industry since about 1880 the looms of the mills were sold to individual workers. In the homes of these dismissed workers the looms hum busily for eight to sixteen hours each day, and someone, possibly even the former manager of a closed mill, supplies the wool and buys the semifinished product at a lower cost than if it were produced in a factory, since the home industries have no social security charges and few taxes. Most of the wool finishing mills are modest in size. Only a few factories have reached the dimensions of medium or big industry. The ability of the Prato District to produce woolen products at the lowest possible cost has been instrumental in its survival.

The metallurgical and engineering industries have had a modest development in Tuscany. The iron ore deposits in western Tuscany and on the island of Elba have been worked since the time of the Etruscans. Prior to World War II ironworks were established at Portoferraio and Piombino for processing Elba ores. Both plants were destroyed during World War II, and only the blast furnaces of Piombino have been rebuilt. The output is small and finds its market primarily in Tuscany.

The metalworking industries of Tuscany employ about 12,000 workers, placing it fourth or fifth among the metalworking regions of Italy. Most of the engineering products are produced in modest artisan shops. It is estimated that only ten firms belong to big industry. Foremost among these are the Livorno shipyards and motorcycle factory at Pontedera.

The region also possesses some glass and ceramic factories. Possibly the most characteristic industries are the arts and crafts, producing mirrors, china, and works of art. Other industries include tobacco and food processing.

Latium. Industry was slow to develop in this region. As late as 1878 Latium had only about five persons per 1,000 inhabitants engaged in industry, whereas in Tuscany and Campania the proportion was twice as large. Manufacturing has grown considerably, and in 1960 over 200,000 industrial workers were located in the area.

The manufacturing of Latium is concentrated in Rome. A number of factors have influenced this localization. The government has established several industries of national importance. About one-quarter of the workers employed by the Italian printing industry work in Rome in the huge government estab-

lishments. About one-fifth of the workers are engaged in tobacco manufacture. In this industry the government employs two-thirds of all workers. Most of the government factories employ more than 500 workers.

The population of Rome has grown greatly in recent years and now exceeds two million persons. As a response to this market potential there is a growing need for expansion of consumer goods industries. Food processing, apparel, pharmaceuticals, and certain types of engineering industries are of increasing importance. With the growth of population the construction industries have flourished. This has led to a brisk demand for cement, bricks, tiles, and fixtures. Only some of these materials are imported; most are produced locally. This has resulted in the expansion of existing plants as well as the development of new plants. The new factories are found not only within the city proper, but in the suburban areas as well.

The South. Southern Italy has traditionally lagged far behind the North in its industrialization (84). In 1950 the Cassa per il Mezzogiorno was established to develop the southern economy. Emphasis was initially placed on agricultural development. However, by 1957 it was recognized that a resurgence of agriculture was not sufficient to reduce unemployment in the South. Far greater incentives, directed precisely toward industry, were required.

In 1957 shortly after the Ministry of State Participation was established, the Italian parliament ordered the state-owned industries to place 60 per cent of their investment in the South. Besides a number of smaller projects four grandiose industrial schemes are being implemented. A new $280,000,000 steel center is being constructed at Taranto, a $250,000,000 petroleum center at Gela, and two 150-megawatt nuclear power stations are on the Garigliano River and at Latina. In addition to the state plants, the Montecatini group is building a $200,000,000 chemical center at Brindisi.

The industrial progress indicates that environmental difficulties are not sufficient to prevent the establishment in the South of a modern industrial system that is sufficiently differentiated and complementary to that in the North. New textile, chemical, engineering, and metallurgical industries have been established. Although most of the new industrial plants have been located in areas where industry already existed, such as in Campania, some industry is developing in the more depressed regions such as Calabria and Basilicata.

Of the cities of southern Italy, Naples has developed the most industry. The consumer goods industries, particularly textiles and foods, are traditional to the area. Other older industries include cement, chemicals, soap and leather. A small iron and steel works is located at Bagnoli and there are shipyards in the bay, notably at Castellammare. The newer industries of Naples include the production of radios, typewriters, and pharmaceuticals.

The industry of southern Italy is still in an early stage of development. Although there is an excess labor supply it is still largely untrained and thus not a major factor in localizing industry. The industrial facilities are still inadequate and their continued expansion will depend not only on government aid but also on the ability to attract private capital from the North. One of the important experiments in the development of industry in an underdeveloped region is occurring in southern Italy.

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CHAPTER FOUR

SOVIET UNION

The Soviet Union since 1928 has been transformed from a relatively backward agrarian nation into the second most powerful industrial nation in the world, exceeded only by the United States. The industrial structure and direction of growth during the Soviet era have been guided by the fundamental objective of maximizing national power. Manufacturing occupies an increasingly important role in the Russian economy. The number of workers in industry has risen from 10,967,000 in 1940 to 20,205,000 in 1959. This represents approximately 30 per cent of the nation's total employment, making manufacturing the principal economic activity in the Soviet Union.

SOVIET INDUSTRIAL PLANNING

Immediately at the conclusion of the communist revolution of 1917, the policy of eliminating private industrial production and establishing state control was inaugurated. This followed Lenin's doctrine that the economic system of the communist state would be operated in compliance with a centralized set of objectives; that is, a plan. The implementation of state control was rapid. On June 28, 1918 it was decreed that all large-scale industries be nationalized. It soon became evident that these nationalized plants were dependent on the functioning of small enterprises, and on December 29, 1920 all small plants were therefore nationalized. By 1923 nearly 85 per cent of all industrial workers were located in government-controlled plants. During the 1920's the few private plants remaining were discriminated against, in that raw materials, labor, and transport were withheld, while at the same time they were taxed more heavily than state-owned plants. By 1930 private plants produced only 5.6 per cent of the total industrial output, and by 1932 they had all but ceased to exist (9).

With the development of state control, the basic concepts of a planned economy were imposed. In such a system, the coordination of production and consumption is achieved

through the decisions of a small group of persons at the head of the government. The plan which regulates output is in effect a law, guiding the economic activities of the nation. Thus given segments of the economy are directed to produce a prescribed quantity. To accomplish this, a given amount of labor, raw materials, and other essentials is allocated. In conjunction with the goals for physical output, financial measures are taken aimed at coordinating production programs with the nation's monetary system. Soviet plans are extremely complicated, since they involve every aspect of economic production.

The development of a planned economy began with the nationalization of economic activities throughout the Soviet Union. In February 1921, the State Planning Commission —*Gosplan*—was established. This organ has remained the nation's chief planning agency. Its original objective—preparing a unified economic plan for the nation, together with the means of implementing it—has not changed. In the period from 1921 through 1927 initial control efforts were being established. The production goals during this period were short-term, usually on a year-to-year basis. Possibly the most important controversy in the early planned economy was whether planning was merely an effort at forecasting the economy's possible future development or whether it resulted in the absolute control of national production. In the late 1920's adherents of the former view were purged from Gosplan.

The establishment of long-term objectives was initiated in December 1927 when the Fifteenth Congress of the Communist Party directed that a five-year program be prepared to direct the economy. The five-year plan began on September 30, 1928. Its basic concept was to achieve the greatest economic growth in a given period of time. If possible, production goals were to be overfulfilled. In practical operation, it was soon apparent that many planned production goals could not be attained.

The first five-year plan was followed by the second, covering the years 1933 to 1937. The third was to extend from 1938 to 1942, but was interrupted in 1941 by the invasion of Russia by the Germans. The plan was replaced by a Mobilization Economic Plan, which was modified to meet the problems of economic development during the war years. At the conclusion of hostilities the fourth five-year plan, covering the years 1946 to 1950, provided a program for the reconstruction and expansion of the Soviet economy (4). In this period there is every indication that a massive effort was made to rebuild Soviet military potential, emphasizing the production of nuclear weapons. The fifth five-year plan, 1951 to 1956, continued the objectives of the previous plan.

The sixth five-year plan, introduced in 1956, was abandoned in September 1957, well ahead of its scheduled termination in 1960. The plan was discontinued in order to redirect the goals of the Soviet economy. To initiate the new objectives, Khrushchev in March 1957 elaborated a series of reforms in a paper titled, "Theses." To implement these measures a radical reorganization of industrial management was decreed. There had been growing criticism of autarchic tendencies in the centrally controlled industrial ministries, which were resulting in inefficiencies and high-cost production. Each industrial ministry had attempted to become self-sufficient. Numerous examples of the disadvantages of this system are available. For example, one ministry had enlarged its Kiev casting shops to supply its other plants, as much as 2,500 miles away, even though the distant towns could have supplied the castings locally at lower costs.

In order to decentralize industrial control, 106 new regional economic councils—*sovnarkhozy*—were established. According to the Theses, "the duties of the sovnarkhozy will include the elaboration and implementation of long-term and current production plans, the elaboration of plans for the specialization of enterprises, plans for cooperation in production and for reciprocal deliveries of raw materials and semifinished products both within the region and to other regions and republics, and the elaboration of plans of material and technical supplies."

The establishment of decentralized industrial controls involves six major goals. The first primary objective is the development of self-sufficiency within individual regions. The increasing railroad traffic and the resulting strain on the system have virtually dictated

the needs for regional self-sufficiency. The second objective, in conjunction with the first, is the planned elimination of high-cost plants maintained by the industrial ministries. The implementation of the objective appears to be successful. For example, by the end of 1957, in the Moscow sovnarkhozy, 72 out of 180 casting shops and 22 out of 24 electrode shops had been closed without reducing output. The third objective is to ensure the maximum utilization of local industrial capacity. For example, in Georgia a railroad repair shop has been converted to the manufacture of diesel locomotives. To make the third objective practical, a fourth goal stipulates that in each sovnarkhozy, materials, labor, and capital will be distributed among the plants of the region in order to improve regularity of distribution of supplies. In conjunction with the fourth objective, the fifth visualizes that each sovnarkhozy will utilize its industrial profits to modernize production methods and equipment. Finally, it is expected that the sovnarkhozy system will release a percentage of the present labor force for more productive work (35).

In the execution of this plan it is made clear that its aim is, as the law states it, "the transfer of the center of gravity of the operative management of industry and construction to the economic administrative areas" while strengthening "democratic centralism." The controls built into this plan are more comprehensive than in former plans. All key plans must, as before, be submitted to the higher central authority. Thus, it must not be assumed that decentralization has any effect upon the lessening of central control. If anything, it is strengthened.

The reorganization of industrial planning in 1957 and 1958 led to the establishment of the seven-year plan, 1959 to 1965. This plan has been compared to the first five-year plan, 1928 to 1932, in that it was introduced during a period of vast changes in the planning and control of the economy. The modifications of production in the seven-year plan are greater than that envisioned in any of the intervening five-year plans. Although this plan is limited to seven years, it sets the basic objectives for a much longer period, extending as much as 15 years into the future (37).

INDUSTRIAL TRENDS

Industrial growth under the tsars. The Industrial Revolution came late to Russia (22). The feudal economy long retarded any significant growth of modern manufacturing. The cotton textile industry in the early ninteenth century was the first to utilize modern machines, which were imported from the United Kingdom. Nevertheless, mechanical weaving did not seriously replace handwork before the early 1870's. In 1866 there were only 42 mechanized cotton mills with 94,000 employees in all of Russia. By 1879 this number had increased to 92, with 162,700 employees. In other types of textile production mechanical advancement was slower.

Although the iron industry is one of the older industries in Russia, it was technically backward until late in the nineteenth century. In the 1880's nearly two-thirds of the pig iron was obtained by using charcoal. In Western Europe the blast furnace which utilizes the hot gases obtained in smelting the ore was introduced in the 1830's, but was only being introduced in Russia 50 years later. Considerable progress occurred in Russia in the development of a modern iron and steel industry after 1880. The development of this industry was primarily a response to the demand of the railroad building program. Between 1885 and 1898 the output of pig iron increased more than four times. By the latter date production exceeded two million tons. In the next 15 years Russian iron output more than doubled, reaching 4,200,000 tons. The output of steel was at about the same level.

In the period between 1885 and 1900 the total output of Russian industry experienced nearly a fourfold increase. From the turn of the century to the outbreak of World War I, industrial output probably doubled. At this time about 10 per cent of the employed population derived their livelihood from industry. The total number employed in factories was approximately 2,500,000.

Of the Russian industries on the eve of World War I, consumer goods were best developed. Of these, textiles held a dominant position. Output of cotton fabrics totaled 2.6 billion linear meters, that of wool 103 million linear meters, and linen 120 million linear

meters. The food industries were also well developed. For example, meat production totaled 1,042,000 tons and granulated sugar 1,347,000 tons. In contrast, the capital goods industries were poorly developed. The level of machine building was rudimentary. A large proportion of the machinery needed for the equipment of plants, particularly such complex types as electrical equipment, turbines, and machine tools, had to be imported from foreign nations. Basic chemical production was barely in an initial stage of development. Cement output totaled only 1,500,000 tons.

In 1913 the industrial position of the Soviet Union was intermediate between the undeveloped lands of Asia and the industrially developed nations of Western Europe and the United States. It is estimated that the total volume of industrial production in France was 2.5 times greater than in Russia, United Kingdom 4.6 times, Germany 6 times, and the United States 14.3 times. The comparative lag in Russian production becomes even more apparent when calculated on a per capita basis. In 1913 the production of electric power was 14 kilowatts per hour per capita in Russia compared with 175.6 kilowatts per hour in the United States; the smelting of pig iron was 30.3 kilograms per capita compared with 326.5 kilograms in the United States; the extraction of coal gave Russia a per capita figure of 209 kilograms while the United States had 5,358 kilograms; and the per capita consumption of cotton in Russia amounted to 3.1 kilograms as compared to 14 kilograms in the United States.

Industrial trends during the Soviet Period 1928-1959. The goals of the planned economy have been to change a predominately agricultural economic structure to an industrial one. There can be no doubt that the Soviet Union has been successful in its development of an industrial economy. However, it is difficult to measure Soviet industrial trends accurately (5). A number of considerations influence a precise understanding of developments. There is no single comprehensive industrial census prepared by the Soviet government. In a number of five-year plans precise production goals were not released. For example, in the fifth five-year plan information regarding production goals was stated in terms of percentages rather than absolute numbers, but no base data were given, and actual production was difficult if not impossible to determine. When value data are utilized to measure production it is difficult to know when there is duplication of data in the manufacture of a single product such as a motor vehicle or a diesel locomotive. There is also little doubt that Soviet statistics are distorted from time to time for political or strategic purposes.

The development of the Soviet industrial economy since 1928 has been phenomenal.[1] From official statistics, total industrial output in 1959 was 39 times greater than in 1928. However, the growth of individual segments of industry reveals some striking differences. From the beginning of planning, the growth of capital goods industries was emphasized over that of the consumer goods industries. The development of the most modern and comprehensive engineering industries has been a consistent goal. Besides an enormous capital investment in industrial facilities, there have also been allied programs in the development of technical training to provide engineers and skilled workers, as well as the exploration for industrial raw materials within the Soviet Union.

In the period from 1928 to 1959 the production of capital goods industries rose 90 times while that of consumer goods increased but 15 times. Of the capital goods, machine building and metalworking industries experienced the greatest expansion. It is estimated that the 1959 output of machine tools was 90 times that of 1928. The output of steel was 14 times greater, coal 19 times greater, and sulphuric acid 40 times greater in 1959 than in 1928. The output of mineral fertilizers rose more than 180 times during this period. In contrast the output of cotton fabrics in 1959 was only 2.2 times greater than in 1928.

Industrial goals of the Seven-Year Plan 1959-1965. The opening paragraph of the seven-year plan indicates its goal to be "in accordance with the program for the development of the productive resources of the Soviet Union during the next 15 years outlined by

[1] The industrial data for this section are taken from *1959 Statistical Yearbook of the National Economy of the USSR*, distributed by Office of Technical Services, U. S. Department of Commerce, Washington, D. C.

TABLE 4.1

Soviet Industrial Production

Commodity	*Unit*	*1913*	*1932*	*1940*	*1950*	*1955*	*1959*
Pig iron	million tons	4.2	6.2	14.9	19.2	33.3	43.0
Steel	million tons	4.2	5.9	18.3	27.3	45.3	60.0
Coal	million tons	29.1	64.4	165.9	261.1	391.3	506.0
Oil	million tons	9.2	21.4	31.1	37.9	70.8	129.6
Mineral fertilizer	thousand tons	69	921	3238	5497	9669	12903
Sulphuric acid	thousand tons	121	552	1587	2125	3798	5081
Synthetic fibers	thousand tons	—	2.8	11.1	24.2	110.5	179.4
Machine tools	thousands	1.5	19.7	58.4	70.6	117.1	147.1
Coal combines	units	—	—	22	344	731	1106
Turbines	thousand kilowatts	5.9	298	1179	2696	5561	7594
Diesel locomotives	units	—	1	5	125	134	1002
Railroad freight cars	thousand units	9.7	15.2	30.9	50.8	34.4	38.6
Railroad passenger cars	thousand units	1.0	1.1	1.0	0.9	1.8	1.8
Motor vehicles	thousand units	—	23.8	145.4	362.9	445.3	495.0
Tractors	thousand units	—	48.9	31.6	108.8	163.4	213.5
Tractor plows	thousand units	—	61.1	38.4	121.9	103.2	154.9
Grain combines	thousand units	—	10.0	12.8	46.3	48.0	54.7
Spinning machines	units	—	39	1109	1958	2040	2328
Bulldozers	units	—	—	118	3788	7511	—
Excavators	units	—	85	274	3540	5250	10210
Cement	million tons	1.5	3.5	5.7	10.2	22.5	38.8
Cotton fabrics	million linear meters	2582	2694	3954	3899	5905	6148
Hosiery	million pairs	—	208	485.4	472.7	772.2	926.1
Woolen fabrics	million linear meters	103	88.7	119.7	155.2	252.3	327.6
Leather footwear	million pairs	60	86.9	211	203	271.2	389.5
Radios and televisions	thousand units	—	29	161	1084	4044	7312
Household refrigerators	thousand units	—	—	3.5	1.2	151.4	426.1
Washing machines	thousand units	—	—	—	0.3	87	724

Source: The National Economy of the USSR (Statistical Yearbook), U. S. Joint Publications Research Service, Washington, D. C. Various years.

the Communist Party and set out at the Jubilee Session of the Supreme Soviet of the U.S.S.R. on 6 November 1957" (37). It is also stated that by about 1970 the Soviet Union has its sights on "winning first place in the world both for absolute output of products and for output per head of the population, which will provide the highest standard of living in the world."

The plan calls for an 80 per cent increase over 1958 in gross industrial output by 1965. Capital goods have a planned increase of 85 to 88 per cent while consumer goods will rise in output between 62 and 65 per cent. During the seven-year period about 70 per cent of all industrial capital investments will be allocated to heavy industry. This maintains about the same ratio of production of capital goods to consumer goods as in the past. The planned average annual increase for capital goods is 9.3 per cent and for consumer goods 7.3 per cent (35).

Within the plan, the goals of certain selected industries are outlined. The chemical industry, one of the most dynamic sectors, is expected to nearly triple its production between 1959 and 1965. A wide variety of products will be produced. For example, plastic production is planned to rise more than seven times and fibers made from polymerization by 12 to 13 times. Some of the chemicals which are well established, such as cellulose fibers and mineral fertilizers, will expand at about the rate of the industry as a whole. In conjunction with the expansion in the chemical industries, oil and natural gas extraction are expected to double and quintuple respectively during the seven years.

The nonferrous metal industries are planned to expand rapidly during the seven-

year period although no over-all gross-value targets have been published. Aluminum output is to nearly triple and copper output has a planned rise of 90 per cent. Considerable increases are also scheduled for nickel, magnesium, titanium, germanium, and silicon. As a result of the exploitation of the newly-discovered diamond pipes in Yakutia, 1958 output of industrial stones is expected to rise 15 or 16 times by 1965.

The output of engineering and other metalworking industries is expected to double during the plan period. Of the engineering industries heavy machine building, instrument-making, radio-electronics, electrical engineering, and machine tools are planned to make notable advancements, while in the machine tool category emphasis is to be placed on special tools. Of the heavy engineering industries the largest growth is planned in railway rolling stock and in chemical and foundry equipment.

Other branches of industry that are planned to exceed the over-all rate of growth include building materials, electrical generation and certain wood and wood substitute products. Of the building materials, the importance of prefabricated concrete components is to be expanded. In 1948, output was eight times that of 1953 and by 1965 is to be 2.5 times that of 1958. In order to support this building program the cement industry is to expand rapidly, along with the roofing, walling material, and window glass manufacturing. Under the seven-year plan the utilization of wood substitutes is to rise rapidly. For example, furniture output is to increase 140 per cent, largely by employing plastics. The growth of electricity receives particular attention in the plan.

Under a planned economy it is an accepted practice to develop one industry at a greater rate than another. In the seven-year plan the rates of growth for ferrous metals, food processing, textiles, and apparel groups are below the levels of the gross industrial output. These groups are planned to increase by about 50 to 70 per cent between 1958 and 1965. An impression is given that the Soviets now believe certain industries such as basic iron and steel have already been developed and greater emphasis must be placed upon other industries.

TRENDS OF SELECTED INDUSTRIES

Iron and steel. The development of the iron and steel industry by the Soviets has occupied a dominant position in their planned economy (7). It was recognized that without iron and steel such basic industries as machinery, transport, and construction equipment could not be developed. It was also recognized than an iron and steel industry is absolutely essential in order to establish a strong military position, since steel is the basis for the production of guns, munitions, armaments, and other military items.

With the institution of the first five-year plan the expansion of the iron and steel industry was assured. In the period from 1928 to 1940 the output of pig iron rose from 3,282,000 to 14,902,000 tons and steel output rose from 4,251,000 to 18,317,000 tons. Increases during this period were obtained by reconstruction and expansion of existing plants as well as by the building of new plants in various parts of the Soviet Union. The most spectacular development in the growth of the iron and steel complex in the 1930's was the creation of the Urals-Kuznetsk Combine, with mammoth new centers of iron and steel rising at Magnitogorsk, Nizhniy Tagil, and Chelyabinsk in the Urals and at Novokuznetsk in the Kuznetsk Basin. Other new steel centers of the 1930's included Zaporozhye in the Ukraine and the Elektrostal plant near Moscow.

Although the output of iron and steel rose rapidly between 1928 and 1940, the distributional pattern changed less than is generally thought. In 1928 the Ukraine had about 72 per cent of the pig iron production; in 1940 it still dominated with 66 per cent of the total. It was not until World War II that decisive changes occurred in the location of the iron and steel industry. In the Ukraine the German invasion destroyed 62 blast furnaces and 213 open-hearth furnaces. To compensate for this loss a mammoth building program was inaugurated in the Urals and western Siberia. In 1943 and 1944, 13 blast furnaces capable of producing 2,300,000 tons of pig iron, 70 steel furnaces capable of producing 2,800,000 tons of steel, and 28 rolling mills with an annual capacity of 1,700,000 tons of finished steel were built in the East.

The destruction and disruption of production in the Soviet iron and steel industry resulted in a significant temporary decline in production. In 1945 only 8,803,000 tons of pig iron and 12,252,000 tons of steel were produced. At the conclusion of hostilities emphasis was placed on rebuilding and enlarging the industry. By 1948 steel production surpassed the prewar level with an output of 18,639,000 tons. Pig iron did not exceed the prewar level until 1949 when 16,389,000 tons were produced. The rapid growth of the steel industry in the early postwar period reflects the availability of large quantities of scrap from the war period.

The Soviet iron and steel industry by 1950 had a production pattern that was considerably altered from that of the prewar period. In 1950 the Ukraine possessed only 47 per cent of the pig iron and 48 per cent of the steel output. It is indicated that by the early 1950's the Chelyabinsk Oblast in the Urals had a pig iron output far exceeding 4,500,000 tons. The Kuznetsk area in the early 1950's was reported to have increased production of pig iron 40 per cent and steel 25 per cent over its peak prewar level. This would imply an output of about two million tons of pig iron and steel.

In the 1950's the production of pig iron and steel expanded rapidly. By the early 1960's output of pig iron totaled about 60 million and steel 70 million tons. There is strong evidence that the distribution of iron and steel production had relatively small changes in the 1950's. In 1960 the Ukraine still possessed about 50 per cent of the pig iron and 40 per cent of the steel output. The steel industry in the Soviet Union remains concentrated in a few centers. Emphasis has been placed on enlarging existing facilities rather than the creation of new centers. There has also been a tendency for each region to become self-sufficient in its raw material needs. With the growth of the industry, there has also occurred a diversification of the types of metal produced. With increasing technological skills and the demands for high-quality steels in the engineering industries, a wide variety of steels is produced.

Under the seven-year plan a target is provided for an output of up to 20 million tons of pig iron in Siberia within ten to 15 years. This "third metallurgical base," as it is designated by the Russians, is presently under development, with two new metallurgical plants in western Siberia. One, the Karaganda plant, is at Temir-Tau in Kazakhstan. This is an integrated plant based on iron ore from the nearby deposits of Atasuski, Karaganda coking coal, and limestone from Topor. The local availability of raw materials provides for low-cost iron and steel. A second plant in the Kuznetsk area in the vicinity of Novokuznetsk was under construction in 1961. This plant, called the second Zapadno-Sibirskiy (West Siberia) will secure its coal from the Kuzbas and its iron ore from the new Angara-Pitskiy deposits. A new railroad is being constructed between Achinsk and Abalakovo to exploit the iron ore reserves.

Besides the new plants at Temir-Tau and Novokuznetsk, two others are in the planning or construction stage. These will be located at Tayshet and Barnaul. The Tayshet plant, to be known as the first East Siberian plant, will utilize coking coal from the Kuzbas and the excellent iron ore deposits at Angara-Ilimsk, a short distance along the Tayshet-Lena railroad. Conditions for an iron and steel industry are also favorable at Barnaul through the utilization of Kuzbas coal and iron ore from the Lisakov deposits. It is important that the creation of these new centers will not require extensive railway construction, which is both complicated and costly in Siberia. Other new centers being considered for future development include a "fourth" metallurgical base in the area east of Lake Baikal.

Engineering industries. The development of the machinery industries has received special attention in the Soviet Union since the first five-year plan in 1928 (13). From official Soviet statistics the output of engineering and metal fabricating industries exceeded the 1913 level by more than 240 times in 1959. In the period between 1940 and 1959 machine building increased ten times. These industries employ about one-third of the nation's manufactural employees and account for approximately one-fourth of the nation's industrial fixed capital.

In the early development of engineering industries, foreign aid was actively sought. A number of American companies supplied machinery for early hydroelectric, steel, alumi-

num, and other production units. The Ford Motor Company gave technical aid to Russia in building the nation's first major automobile factory at Gorkiy. Many foreign engineers served as technical advisors in constructing the initial machinery plants. However, by the end of the second five-year plan Soviet engineers and technicians had gained such skill that foreign technical aid was needed only for the most advanced mechanical construction. As a result imports of machinery and technical aid declined greatly.

The Soviet engineering industries were disastrously affected in many regions during World War II. The factories in areas unaffected by the war were rapidly converted to the production of direct military supplies. This conversion was aided by importing great quantities of machinery from the United States. Because of the availability of foreign equipment, new factories could be built in the East, and production of military materials greatly expanded.

Since World War II, emphasis has continued to be placed on the output of the engineering industries. In the immediate postwar years there was a need to re-equip the factories damaged or destroyed during the war, as well as to enlarge the industry in the East. This was accomplished by a number of measures. First, a considerable quantity of machinery was seized from conquered countries. Second, domestic production was enlarged, and third, the Soviet Union imported great quantities of machinery. This third objective was only partially successful, since a high demand for machinery in the United States limited exports in the immediate postwar period, and shortly thereafter a virtual embargo was imposed upon American exports.

In the 1950's major production advances were made in the output of the machinery industries. Although many of the industries are discussed more fully in the topical chapters, the following presents a brief analysis of production trends in some of the chief branches of Soviet machine building.

The growth of the machine tool industry in the Soviet Union since 1928 is a basic key to progress in other engineering industries. In 1913 Russia produced about 1,800 machine tools. In 1928 at the beginning of the first five-year plan output was but 2,000. By 1938 considerable progress had been achieved when 55,300 tools were produced. Prior to World War II turret lathes were produced in Moscow, milling machines in Gorkiy, gear-cutting tools and combination lathes in Sverdlovsk, and automatic machine tools in Kiev as well as in a number of other places. Production of machine tools was retarded during World War II, but since then has continually risen. Annual output from 1948 to 1959 rose from 64,500 machine tools to 147,100. Of the machines produced in 1959, 36,795 were lathes, 31,693 were vertical drilling machines, 14,378 were milling machines, and 7,958 were precision machines. The Soviet Union now produces the most advanced types of machine tools. In recent years the country has developed a small export trade in machine tools.

The farm machinery industry was among the first developed by the communists. Among the major farm machinery plants built in the 1930's were the tractor factories at Volgograd, Kharkov, and Chelyabinsk; the combine plants at Zaporozhye, Rostov, Saratov, and Lyubertsy; and the giant agricultural machinery plant at Rostov. During World War II a number of agricultural machinery plants were moved eastward. In recent years new agricultural machinery plants have been built at Lipetsk, Vladimir, and Minsk. The output of agricultural machinery has grown rapidly. Tractor production increased from 51,000 in 1937 to 108,800 in 1950, and reached 213,500 by 1959. Tractor production has emphasized the manufacture of both diesel and caterpillar types. Other farm machinery production has also increased. The output of tractor plows rose from 96,700 in 1937 to 154,900 in 1959; tractor cultivators in the same period rose from 68,100 to 121,500. The output of grain combines increased from 43,900 in 1937 to 54,700 in 1959. A number of farm machines such as corn and beet harvesting combines have been produced in the Soviet Union for the first time since 1950.

The transport industries have undergone rapid expansion since 1928. The output of motor vehicles has risen from 841 to 495,000 in 1959, of which about 75 per cent were trucks and busses. The traditional centers of the motor vehicle industry at Gorkiy, Moscow,

and Yaroslavl have been enlarged and new plants built at Miass, Dnepropetrovsk, Kutaisi, Ulyanovsk, Pavlovo, and Novosibirsk. Automobile parts are manufactured at various other plants located in Leningrad, Yaroslavl, Moscow, Kirzhach, Saratov, Kuybyshev, Minsk, Odessa, Lvov, Irkutsk, Kurgan, and Sverdlovsk.

The locomotive and railway car industry was modestly developed during the tsarist period. The old plants at Kolomna, Leningrad, Sormovo, Bryansk, Revel, and Kharkov were reconstructed and are now major centers. New plants have been built at Nizhniy Tagil, Dneprodzerzhinsk, Kremenchug, Ust-Katav, Krasnoyarsk, and Ulan-Ude. The output of diesel engines has increased from 125 in 1950 to 1,002 in 1959, and the output of passenger railway cars has risen in the same period from 912 to 1,790. Output of freight cars has, however, declined from 50,800 in 1950 to 38,600 in 1959. The shipbuilding and aircraft industries are also well developed in the Soviet Union, but production figures have not been released by the government for these industries.

The Soviet Union also produces a large variety of industrial and power equipment. The growth of these industries follows essentially the same trends as other engineering industries. There has been a major rise in oil industry equipment from 15,500 tons in 1940 to 47,900 in 1950 and 76,500 tons in 1959. Metallurgical equipment during the same period rose from 23,700 to 200,500 tons. In the production of power-producing and electrical engineering equipment the output of turbines of 1,000 kilowatts or more capacity increased from 1,156 in 1937 to 2,696 in 1950 and 7,594 in 1959. The production of electric motors of 1,000 kilowatts capacity or greater increased from 1,221 in 1937 to 4,244 in 1950 and 12,361 in 1959. As in other engineering industries the principal areas of production are the Central Industrial Region, the Urals, and the Ukraine. New plants built since the war are being located in many parts of the country, particularly in the East.

Chemical industries. The chemical industry of the Soviet Union has largely been developed since 1928. During the tsarist period chemical production was in its initial stages. Many types of chemicals were imported, as well as most chemical raw materials. During this early stage the industry was oriented to the markets of the Leningrad and Moscow areas.

In the first five-year plan, targets were established for a chemical industry. Production grew rapidly in the 1930's. During the second five-year plan the Soviets reported a growth of 200 per cent, and in 1938 the industry accounted for 6.4 per cent of the value of all Soviet industrial output. During the 1930's many new plants were built in the Soviet Union, employing modern techniques and equipment. In this growth technical aid from the United States, Germany, and many other foreign countries played an important part in creating the Soviet chemical industry.

The chemical industry suffered greatly during World War II. Many of the plants were located in German-occupied territory and were seriously damaged or destroyed. In unoccupied areas, the industry was utilized almost exclusively for meeting military needs. For example, 252,000 tons of concentrated nitric acid were produced in the East in 1942, and 342,000 in 1943, as compared with 232,000 in the whole of Russia in 1940. Large quantities of chemicals had to be imported during World War II to meet military needs.

In the early postwar period the development of the chemical industry was rapid. At the completion of the fourth five-year plan in 1950 the official Soviet statistics indicated that chemical production was 80 per cent above the prewar level. At this time it is estimated that gross output of chemicals was 50 times greater than in 1913. With continued growth in the 1950's it is estimated that in 1958 the gross output was 127 times that of 1913. The seven-year plan places emphasis on growth of certain branches of the chemical industries, particularly in the area of petrochemicals required to produce such products as plastics, synthetic fibers and rubber. The target of the plan calls for increasing synthetic fiber capacity 4.6 times by 1965, plastics and resin capacity 8 times, and synthetic rubber capacity 3.4 times.

The basic chemical industry is well developed in the Soviet Union. Production data has, however, been revealed only for sulphuric

acid, caustic soda, and soda ash. Production of sulphuric acid has risen from 1,469,000 tons in 1937 to 2,125,000 in 1950, and 5,081,000 in 1959. Sulphuric acid plants are oriented to the pyrite deposits of the Urals, East Siberia, and Transcaucasia as well as to consuming centers. The largest plants in the Soviet Union are located at Konstantinovski and Odessa in the Ukraine; Leningrad; Voskresensk in the Moscow Oblast; and Berezniki in the Urals.

The soda industry, whose basic raw material is salt, has grown rapidly under Soviet impetus. Caustic soda output has increased from 163,700 tons in 1937 to 630,000 tons in 1956, while production of soda ash during the same period rose from 528,000 to 1,500,000 tons. The main centers of soda production are Berezniki and Sterlitamak in the Urals, and the Donbas in the Ukraine. Ammonium sulphate, benzol, toluol, and various other coke by-products are produced in each of the metallurgical centers.

The synthetic chemicals such as rubber, fibers, and plastics have become of great importance to the Soviet economy in recent years. The attempts of the Soviet Union to acquire self-sufficiency in chemicals is possibly best illustrated by progress in synthetic rubber production. In 1926 the Soviet government built its initial plant to produce rubber from alcohol. The first synthetic rubber plants were built in the potato growing area, using ethyl alcohol extracted from potatoes. Before World War II such plants were built at Yaroslavl, Voronezh, and Yefremov in Tula Province. Synthetic rubber can also be obtained from petroleum and development has been oriented to oil fields such as the plant at Kazan on the Volga, at Sumgait in Azerbaijan, and Stavropol in the Kuybyshev Oblast to utilize ethylene, a by-product of the cracking process in petroleum refining. Synthetic rubber is also obtained from calcium carbide. A plant built at Yerevan is based on this raw material. Finally, alcohol is obtainable from sawdust and other lumber industry products so that the synthetic rubber industry has also been developed in the rich lumber areas of the north and east. As a result of these endeavors synthetic rubber output has risen from 35,000 tons in 1935 to about 200,000 tons in 1950 and possibly double this figure in 1960.

The fertilizer industries are among the best developed in the Soviet Union. During the 1930's superphosphate plants were built at Voskresensk in the Moscow Province, at Konstantinovka in the Donets, and at Leningrad. Nitrogenous fertilizer plants, producing ammonium sulphate, developed in the iron and steel centers of the Donbas, Kuzbas, Magnitogorsk, and others. In the Urals a potash plant was built at Solikamsk utilizing the enormous local deposits of potassium. The fertilizer plants are thus oriented to raw materials as well as agricultural regions. Official reports of the Soviet Central Statistical Office indicate that production of mineral fertilizers has risen from 3,240,000 tons in 1937 to 5,497,000 in 1950, and in 1959 12,900,000 tons were produced. The seven-year plan has a target of 19,600,000 tons by 1965. This means that in the seven-year period annual output must rise 5,700,000 tons. This is a higher average annual increase than before, but is possibly feasible because of the emphasis on construction of new fertilizer plants. The seven-year plan calls for the construction of 140 new chemical combines, in addition to the reconstruction of 130 existing ones.

Consumer goods industries. During the Soviet period the consumer goods industries have grown at a much slower rate than that of capital goods. Where official figures indicate significant increases over the 1913 period they are subject to question because of frequent noncomparability of data. It is also important to recognize that although production has risen it can be questioned whether it has kept pace with the rising population.

In the development of the consumer goods industries much evidence is available that little attention is directed to quality or variety of products. During the 1930's and 1940's the Soviet press published many items relating to the low quality of shoes and clothing. During World War II and the early postwar period, there was a dire shortage of consumer goods. In 1953 a much publicized program was inaugurated to increase the consumer goods industries. This program had two important policy implications. First, the production of consumer goods was given a specific target output. In previous years consumer goods usually were far below planned production

because of the low priority given these industries in raw materials, equipment, and labor. Second, for the first time, the government provided the people with an appreciable amount of durable consumer goods such as refrigerators, washing machines, and television sets. Although the wealth of the average Soviet citizen is far below the standard in the United States, some progress has been made (26).

Of consumer goods, the textile and apparel industries play a prominent role. These industries were of major importance in the industrial structure of tsarist Russia. At this time the industries were concentrated in the Central Industrial Region in such cities as Moscow, Ivanovo, and St. Petersburg (Leningrad). In the Soviet period the tsarist textile centers have remained important, but new centers have been developed such as in Western Siberia and Central Asia in order to secure a more equitable distribution. For example large cotton combines are now situated in Barnaul, Kherson, Dushambe, Krasnodar, and Engels. Of a textile production in 1959 of 8,696,000,000 linear meters, cotton textiles predominated with an output of 6,148,000,000 linear meters followed by silk fabrics with 800,900,000 linear meters, synthetic fibers with 795 million linear meters, linen fabrics 526 million linear meters, and finally woolen fabrics with an output of 327 million linear meters.

The apparel industry in tsarist Russia was carried on mainly as a handicraft. The workers were artisans working singly or in small groups. The only apparel factories were found in Leningrad and Moscow, near the raw materials and the largest market. Under the Soviet regime the artisan apparel industry has essentially disappeared. Factories have been built in many parts of the country largely oriented to a market rather than to raw materials. The growth of this industry has, however, been hampered by the low priority given to it for capital improvements and labor. Consequently, output has lagged far behind demand. In recent years there has been some evidence that production is improving. For example, the output of hosiery has increased from 485,441,000 pairs in 1940 to 926,076,000 pairs in 1959. During the same period the output of knitted underwear rose from 124,400,000 units to 438,662,000 units.

The development of the shoe industry in the Soviet Union follows basically the same pattern as that of textiles and apparel. In tsarist Russia it was concentrated in the hands of artisans. The industry depended heavily on foreign raw materials and equipment. Under the Soviets the artisan industry has been destroyed. Production is concentrated in factories, and a domestic leather industry has been developed. The inadequacy of the leather industry due to the small livestock activity of the nation has long handicapped shoe production. In order to overcome this basic deficiency the development of substitutes has been actively pursued. During the 1930's the shoe industry was greatly enlarged in the older centers of Moscow and Leningrad, and many new centers developed, oriented to a regional market. The shoe industry suffered great damage in World War II but has recovered to make remarkable strides in recent years. Output in leather footwear has grown from 203,013,000 pairs in 1950 to 389,500,000 in 1959.

In the development of the Soviet economy a distinguishing characteristic has been that the growth of the metallurgical industries has not greatly increased the availability of durable consumer goods. The production of such items as washing machines, vacuum cleaners, and refrigerators, has lagged notably. The metal that is produced is used for military endeavors rather than for consumer goods. In governmental planning the production of these items has received little attention and has frequently been relegated to a subordinate place in industrial output. There is some evidence that this situation has gradually been altered since 1953. For example, output of sewing machines rose from 993,000 units in 1953 to 2,941,000 in 1959. In the same period output of clocks and watches rose from 12,838,000 to 26,200,000, radio sets increased from 1,725,000 to 4,035,000, vacuum cleaners rose from 45,500 to 367,500, and output of refrigerators rose from 49,200 to 426,100. Nevertheless, with a population of about 220 million persons, it is apparent that only a relatively few are able to acquire these durable consumer goods.

LOCATION OF MANUFACTURING

Localization during the tsarist era. In tsarist Russia manufacturing was highly concentrated in a few centers in the western portion of the country. The greater share of the industry was localized in the Central Industrial Region. The industrial rise of this region is attributable to a number of factors. Since the days of Peter the Great, and especially since the time of Alexander II, the government protected and fostered the industrial growth of the area. For example, the railway freight rate structure was so determined that it gave preferential rates for the flow of raw materials into the area and for the distribution of finished goods out of the region. There was also a deliberate government policy to hinder the growth of other regions.

The central position in European Russia of this region also provided advantages. In the nineteenth century Moscow became the hub of the railroad network of European Russia. Because this area possessed the largest and most prosperous population in the nation, it provided the greatest market in Russia. The large population also provided a labor supply. This region was not only an early center of handicrafts, but the factory system was established in the early nineteenth century. The handicraft workers provided the initial skilled labor for the factory system. For example, the skilled shoemakers who developed around the village of Kimry played an important role in the establishment of shoe factories. Gradually a body of skilled industrial workers developed in Moscow, Ivanovo, Gorkiy, and other cities. Although some early industry was established on the availability of wood and lignite and such raw materials as wool and flax for linen, few major industrial areas are as devoid of fuel and industrial raw materials. Because no single factor localized the industry in a given area, the early industry was widely dispersed, with the greatest concentration focusing on the Moscow area.

Outside of the Central Industrial Region only a few centers were able to develop. Of these, St. Petersburg (Leningrad) was significant. It possessed advantages similar to that of the Central Industrial Region such as a large population providing labor and a market, an excellent transportation hub, an industrial heritage, and the advantage of being the leading port in northwestern Russia. At an early date it developed manufacturing based on imported raw materials and industrial equipment. Because it was the capital city many luxury industries grew to satisfy the market provided by the nobility.

The principal heavy industrial region of tsarist Russia evolved on the coal fields in the Donbas area of the Ukraine. On the eve of the 1917 Revolution this area provided about three-fourths of the iron and steel of the nation. The Urals iron industry had long been in a state of decline and was of minor importance by the early twentieth century.

At the close of the tsarist era, it is estimated that about 50 per cent of the industry was concentrated in the Central Industrial Region. Leningrad and the Ukraine each possessed an additional 20 per cent. Less than 10 per cent of Russian industrial production was located in the eastern portion of the nation. Of these areas, the Urals were estimated to have had about 4.7 per cent of the nation's total industry, Siberia 2.4 per cent, and Turkestan 1.8 per cent.

Localization during the Soviet Period. The Soviet government has from its earliest days sought to decentralize the nation's industrial capacity. Three basic objectives have prompted the planned dispersal of industry. First, it was early recognized by the government that if the nation was to develop effectively all potential industrial regions had to be developed. Second, the Soviets have always been conscious of the possibilities of foreign invasion. The tsarist industrial areas situated on the western rim of the nation were subject to early conquest if an attack came from Europe. For security reasons it was desirable to shift the industrial base eastward. Third, according to Lenin's doctrines, the tsarist policy was to exploit the peripheral regions for the benefit of the center. The Soviets have as a basic goal the changing of the peasant agrarian economies in all regions to industrial economies. It is thus hoped that the standard of living in these areas will be raised, while at the same time the economy of the entire nation will be strengthened (35).

In the first five-year plan the official policy concerning decentralization of industry was stated as "unceasingly concerned with the development of the production resources of the eastern regions, with creating new economic centers which play an immense role in building socialism and in preparing the defense of the country." [2] Although the details of implementing this policy have changed with circumstances, the basic goals have remained firm.

Early locational trends. With the implementation of the first five-year plan in 1928, there were immediate efforts to develop new interior centers of industry. Between 1928 and 1932 the most spectacular development was the evolution of the famous Urals-Kuznetsk Combine, and the resulting creation of new heavy metallurgical centers. As a result industrial growth in the East was significant during the 1930's. By 1940 it is estimated that gross industrial output in the Urals was 14 times greater than in 1913, in West Siberia 29 times greater, and in the Far East 18 times greater. It must, however, be remembered that industrial production in 1913 was extremely low.

Although the industrial regions of the East were growing at a more rapid rate than the older areas, a large percentage of new capital investment in industry was assigned to the older established areas. Not only were established industries reconstructed but vast new plants were built. As a consequence industrial production at the beginning of World War II was still concentrated in the regions established during the tsarist era.

There were a number of factors that retarded decentralization. First, the Soviet regime was forced to utilize the industrial base created during the tsarist period in order to provide the initial industrial equipment. This, however, in turn meant that a huge capital outlay was required in the older established regions. Second, the railroad facilities of Russia were well developed only in the older industrial regions. The Soviets during the early stages of growth did not have sufficient industrial strength to enlarge the existing railroad network greatly. Third, the known industrial resource base during the early years of the Soviet regime was concentrated in a few areas accessible only by the existing railroad network. With little increase of this network, the existing resources could be utilized far more intensively than before, whereas the exploitation of new resource areas would have necessitated new railway investment. It must also be recognized that the vast industrial resources now known to exist in the Soviet Union have only been discovered in recent years as a result of intensive geological exploration. Finally, the emphasis in the early Soviet five-year plans favored the utilization of the known mineral base and the existing railway system. The minerals most highly developed during the tsarist period were coal and iron ore, and these were fundamental to planned Soviet industrialization. In order to obtain the maximum advantages from large-scale operations, the concentration of heavy metallurgical industries near the resource base was emphasized in the early Soviet industrial experiment.

Locational changes during World War II. World War II had a profound influence on the location of industry in the Soviet Union (33). The western industrial regions were immediately under attack with the outbreak of war in 1941. In the course of the war the entire Ukrainian industrial region was lost to the Germans, and the Central Industrial Region and Leningrad experienced considerable damage from aerial attacks. The Russian territory occupied by the Germans included about 40 per cent of the total population and produced about 63 per cent of the prewar coal output, 68 per cent of the iron, 58 per cent of the steel, and 60 per cent of the aluminum.

In the first week of the war, the Mobilization Economic Plan made industrial relocation a major goal, as well as the construction of new plants in the East. From July through September 1941, 1,360 large enterprises were evacuated to the East. Of these factories, 455 were rebuilt in the Urals, 210 in Western Siberia, and 250 were re-established in Central Asia and Kazakhstan. Of these plants 210 came from the Moscow area alone. As a result the industrial output of Moscow declined temporarily. It was only in the later stages of

[2] Feigin, Ya., Razmeshchenie proizvodstva pri kapitalisme i sotsializme, Moscow, 1958, p. 492.

the war that reconstruction brought about a new and rapid rise in Moscow industry.

In the industrial development of the East during the war years, the building of new plants, especially metallurgical and engineering factories as well as electric stations, was extensively undertaken. During the war years, 1941-1945, 2,250 large industrial installations were newly built in the eastern regions. In the same period new coal mines with a capacity of 29,800,000 tons of coal, turbines with a capacity of 1,860,000 kilowatts, blast furnaces with a capacity of 2,405,000 tons of pig iron, open-hearth furnaces with a capacity of 2,474,-000 tons of steel, and rolling mills with a capacity of 1,226,000 tons of rolled metal were placed in operation in the eastern regions.

Of the regions that expanded during the war years, the Urals played a dominant role. As a result of the efforts expended they emerged in 1945 as one of the largest of the country's industrial regions. The Urals, along with the Kuznetsk Basin, were transformed into a major base for the production of ferrous metals. The importance of the Urals as a producer of nonferrous metals also rose. More aluminum and magnesium were produced in the Urals and Western Siberia in 1943 than in all of the U.S.S.R. in 1940. The energy base was also greatly improved, with new developments of petroleum resources and the expansion of electrical facilities. During this period the machine industry grew rapidly, and the Urals were soon capable of supplying 40 per cent of the war industry output. The new branches of machine building appearing in the Urals during the war included tanks, motor vehicles and motorcycles, ball bearings, electrical equipment, and machine tools.

The increase of industrial output of the Volga region was fourfold between 1940 and 1945. During this period the structure of the industry was altered radically. The metal working industries increased nearly nine times. The relative share of these activities in the Volga region's total industry rose from 31 per cent in 1940 to 74 per cent in 1945. New industries in the Volga region included aircraft and aircraft engines, ball bearings, and motor vehicles.

The importance of Western Siberia in the nation's industrial structure increased considerably. Between 1940 and 1945 there was a threefold increase in total industrial output. The production of quality steels and ferroalloys was introduced in Western Siberia. Nonferrous metallurgy also expanded. The most striking advances were made in the metalworking and machine building industries. Between 1940 and 1945 these industries increased by elevenfold.

The structure of industry in Transcaucasia, Central Asia and Kazakhstan was also changed by the war efforts. The fuel and metallurgical industries were strongly developed. As in other regions of the East emphasis was placed on heavy industry, particularly metallurgy and machine building.

Recent locational trends. At the conclusion of hostilities the fourth five-year plan had as one of its major objectives the reconstruction of the war-devastated areas as well as the continued industrial growth of the East. From official statistics there is every evidence that the Soviet industrial economy had recovered from World War II devastation by 1950. Although growth in the East may have received more public attention after World War II, the industrial expansion of the western regions was of major proportions. At the conclusion of the fourth five-year plan in 1951, Soviet data indicate that the western regions possessed 67.5 per cent of the industrial fixed assets of the nation and the eastern regions 32.5 per cent (Table 4.2). The Central Industrial Region remained the largest with 20.7 per cent of industrial fixed assets, followed by the Urals with 14.0 per cent.

During the 1950's evidence indicates that there was no basic change in the geographical pattern of Soviet industry. Although gross industrial output rose, each region maintained about the same share of the increase in output. In 1956 the western regions still possessed 67.1 per cent of the industrial fixed assets and the eastern regions 32.9 per cent. One of the reasons for the withdrawal of the sixth five-year plan (1956-1960) in 1957 was that it did not provide adequately for developing the resources of the East.

The establishment of the seven-year plan, 1959-1965, places renewed emphasis on eastern industrial growth (Table 4.3). A number of recent developments will aid in implementing

TABLE 4.2

Regional Location of Industrial Fixed Assets

1925-1958

Percentage of total on 1 January of each year for national territory

	1925	*1930*	*1951*	*1956*	*1958*
European RSFSR	63.9	59.2	38.7	37.3	—
North	0.7	0.8	2.1	1.9	—
Northwest	15.8	14.9	6.7	6.2	—
Center	38.0	33.7	20.7	18.8	—
Volga	4.5	4.4	4.9	5.4	—
North Caucasus	4.9	5.4	4.3	5.0	—
Ukrainian SSR	21.9	23.0	20.1	20.2	20.2
Moldavian SSR			0.2	0.4	0.4
Azerbaijan SSR	5.2	6.7	2.9	3.1	2.8
Georgian SSR	0.3	0.7	1.5	1.8	1.7
Armenia SSR	0.1	0.2	0.7	0.7	0.7
Belorussia	0.7	1.0	1.4	1.6	—
Latvian SSR	—	—	0.9	0.8	1.6
Estonian SSR	—	—	0.7	0.7	0.8
Lithuanian SSR	—	—	0.4	0.5	0.6
Total Western Region	92.1	90.8	67.5	67.1	—
Asian RSFSR	6.9	7.4	26.3	26.5	—
Urals	4.9	5.1	14.0	13.8	—
West Siberia	0.9	1.2	5.4	5.2	—
East Siberia	0.4	0.4	3.3	3.9	—
Far East	0.7	0.7	3.6	3.6	—
Kazakh SSR	0.4	0.7	3.0	3.4	3.3
Uzbek SSR	0.5	0.7	2.0	1.7	1.6
Turkmen SSR	0.1	0.2	0.5	0.6	0.6
Kirgiz SSR	—	0.1	0.4	0.4	0.4
Tadzhik SSR	—	0.1	0.3	0.3	0.3
Total Eastern Region	7.9	9.2	32.5	32.9	—
USSR (Index 1925 = 1)	1.0	1.6	17.9	24.9	30.6

Source: Economic Survey of Europe, 1959, Economic Commission for Europe, Geneva, 1960, pp. iv-15.

the new industrial goals. First, the discovery and development of the natural resources of the area, particularly minerals, has been phenomenal in recent years. Since the early 1950's a full range of geological surveys have been in progress. The discovery of new mineral wealth in the Soviet Union has been immense, and virtually all new deposits, with the exception of Kursk-Belgorod iron ore, have been in the East. Second, the labor force in the East has been greatly increased in recent years. In the period between the censuses of 1926 and 1959, the population in the East rose 78 per cent, whereas the total national population increased by only 25 per cent. As a response to eastward migration and the movement from rural to urban areas, the town population in the East rose by 119 per cent from 1939 to 1959, while the rural population declined by one per cent. As a result the East is more urbanized than the West (50 per cent against 49 per cent in 1959). Third, the transportation system of the East has been improved in recent years, and the seven-year plan envisages the extension of the railways to many of the newly discovered resources. Almost all the new railway construction of the nation is to occur in the East. By 1965 19 per cent will be added to the region's network.

Although the seven-year plan does not reveal the planned industrial output by region, some information on production goals is published for individual products. Over half of the increment forecast in the plan is to occur in the eastern regions, since the output of coal, petrochemicals, cement, and window glass, and the planned increases for iron and steel, woolen fabrics, and soft roofing are all substantial. Under the planned targets the eastern regions will produce as much coal in 1965 as

TABLE 4.3

Industrial Output Originating in the Eastern Regions of the Soviet Union, 1940-1965 Plan

	Per cent of total output				
	1940	*1950*	*1955*	*1958*	*planned 1965*
Coal	35.9	47.0	46.9	46.9	50
Crude oil	9.0	—	—	28.5	30
Electricity	22.4	37.8	37.3	—	46
Pig Iron	28.5	47.5	42.9	—	44
Crude Steel	32.1	52.7	47.2	—	48
Rolled Steel	32.2	52.2	48.0	—	49
Refined Copper	—	—	—	—	88
Aluminum	—	—	—	—	71
Cement	19.5	25.7	27.8	32.1	42
Window Glass	14.3	12.4	21.4	20.8	39
Soft Roofing	2.2	5.5	7.2	8.0	26
Lumber	39.7	41.0	43.5	43.9	—
Industrial Timber	38.8	40.1	44.0	44.7	52
Sawwood	36.6	33.9	38.4	39.9	45
Cotton Fabrics	3.8	7.2	7.7	8.3	11.4
Wool Fabrics	2.7	4.9	4.8	4.6	21.5
Silk Fabrics	8.2	12.3	7.3	6.7	44.6
Knitwear	6.2	14.4	12.5	13.0	27
Hosiery	4.3	9.1	7.9	7.9	26
Leather	10.5	17.1	19.2	19.4	23
Fish	39.3	41.0	33.0	38.5	30

Source: Economic Survey of Europe, 1959, Economic Commission for Europe, Geneva, 1960, pp. iv-20.

the whole of the Soviet Union in 1952, as much ferrous metals as in 1954, as much crude oil as in 1955, and as much electricity as in 1958.

Manufacturing Regions

The major manufacturing belt of the Soviet Union lies chiefly in the triangular-shaped area outlined by Leningrad, Odessa, and the Ural Mountains (Map 4.1). Within this area five industrial regions are important. These are the Central Industrial Region, the South, the Leningrad Industrial Node, the Urals, and the Middle Volga Region. About 70 per cent of total Soviet manufacturing is concentrated in this belt.

Outside this area of concentration a number of other regions are important. The major districts are the Kuznetsk Basin, Caucasus, Central Asia, Lake Baikal, and the Far East. A number of isolated manufacturing cities are located outside the major manufacturing regions. These include Omsk, Karaganda, Krasnoyarsk, and Arkhangelskaya.

Central Industrial Region. The Central Industrial Region is the principal manufacturing area of the Soviet Union (Map 4.2). Within the broad area of Smolensk on the west, Voronezh on the south, Kirov on the east, and Rybinsk on the north, the concentration of industry lies in the triangle outlined



4.1. Manufacturing Regions of the Soviet Union.

by the cities of Moscow on the west, Gorkiy on the east, and Yaroslavl on the north.

Industrial trends. During the tsarist period consumer goods held first place in the industrial output of this region. Of these goods, textiles were predominant. Two-thirds of all industrial workers were engaged in this single industry. The second category of manufacturing was engineering, with about one-tenth of the industrial workers. Small-scale metallurgy and simple machine building prevailed in the engineering industries. The chemical industries employed fewer than 2 per cent of the labor force.

With the establishment of the Soviet regime, the Central Industrial Region continued to thrive. However, as a result of the Soviet emphasis on heavy industry, the industrial structure of the region was radically changed during the early five-year plans. The consumer goods industries declined relatively in importance and the capital goods industries increased their role greatly. At the end of the second five-year plan the Moscow area accounted for nearly one-quarter of machinery production and electric steel, and consumed about one-sixth of all metal produced in the nation.

The Central Industrial Region has maintained its industrial importance to the present. Although its relative position has declined somewhat as new centers develop in the country, its absolute production has continued to rise. It is estimated that this region produces about one-quarter of the industrial output of the Soviet Union. Such factors as market potential, excellent transportation facilities, skilled labor, and developed industrial facilities continue to act as important industrial localizing determinants.

Industrial structure. The Central Industrial Region is characterized by its diversity of manufactured products. Within the region the Moscow area is most diversified, producing such items as steel, machine tools, heavy and precision machinery, motor vehicles, aircraft, electronic equipment, diesel locomotives, chemicals, wood and paper products, ceramics, textiles, leather and rubber goods, and food and tobacco products, as well as a host of other items. Many of the cities of the region specialize in one or several industrial products, but because of the large number of centers regional diversification is achieved.

Engineering industries. The engineering industries of the Central Industrial Region, like those of Leningrad, specialize in the production of complex and precision machines which require skilled labor and relatively small quantities of raw materials. Although this region is the leading consumer of iron and steel in the Soviet Union, this industry is not well developed. The lack of extensive deposits of iron ore and coking coal has greatly retarded its growth. However, a number of small iron and steel centers have developed. Of these, the iron and steel industry at Tula, existing since the eighteenth century, is of importance. This iron and steel center is based on local deposits of iron ore, and although the district lies in the Moscow lignite basin, the coal is noncoking and fuel must be imported. Primarily as a response to the regional demand for iron and steel, a modern iron and steel industry has been developed during the Soviet era. The old metallurgical works at Kosaya Gora south of Tula have been rebuilt and a new plant has been constructed at Novo-Tulski east of the city.

A number of other small iron and steel plants exist in the region. In the Gorkiy District metallurgical plants are found at Vyksa, Kulebaki, and Tashino. In the southern portion of the region, Lipetsk has an iron industry dating from the time of Peter the Great. On the eastern edge of the region steel plants have developed at Kirs, Peskovka, and Omutninsk. These isolated centers had their origin based on local iron ore and coal, and although these resources are now largely exhausted the iron and steel industry persists because of a local market, skilled labor, and an established plant.

Under the Soviet regime there has been the development of steel centers based on electric furnaces, producing quality steel. The raw material for these plants come from scrap from the area's engineering industries. Moscow and Elektrostal are major centers of specialty steel production.

The engineering industries are widely dispersed in this region. Nearly every town with industry has a machinery or metal fabrication plant. Nevertheless, three districts have

achieved a prominent position. Of these, none surpasses the Moscow District. It is difficult to name a branch of metal fabrication and machine building which is not found in this city. Thus, diversification is a major characteristic of Moscow's engineering industries. In recent years a large number of industrial cities have developed around Moscow. Many of these have become known for particular engineering products. Tramways and subway cars are made at Mytishchi, locomotives, rolling steel and textile machines at Kolomna, locomotives at Babushkin, railway cars at Lyublino, metalworking at Noginsk, instruments and tractor parts at Elektrostal, petroleum refining equipment, boilers, and sewing machines at Podol'sk, and motorcycles at Serpukhov.

In the eastern portion of the region, the Gorkiy District holds a dominant position in the engineering industries. Within the city of Gorkiy, machine building is the major industry. This city is the nation's leading producer of motor vehicles and is also noted for its output of locomotives and rolling stock, airplanes, ships, diesel engines, electronic equipment, and fabricated metal goods. A number of other centers in the Gorkiy area are noted for their engineering industries. Pavlovo and the nearby town of Vacha have established metalworking plants based on handicraft cooperatives. The principal products are tractor and motor vehicle parts, surgical instruments and such hardware items as locks and scissors. Shipyards are located along the Oka River at Doschatoye and Lipiya and on the Volga at Imeni and Balakhna.

In the Yaroslavl District a number of cities produce engineering products. The city of Yaroslavl manufactures agricultural machinery, electric motors, and motor vehicles and parts. There are also shipyards and railroad shops. Rybinsk is noted for its output of road construction machinery, ships, and excavators. Ships are also built at Kostroma.

A large number of isolated centers produce a variety of machines and metal products. Kirov manufactures railroad equipment and has machinery works. Agricultural machinery, cash registers and electronic equipment are manufactured in Ryazan; tractors at Lipetsk; aircraft, agricultural implements, excavators, bridge equipment, flour milling machinery and diesel motors at Voronezh; machinery and railroad stock at Bryansk; and machinery at Skopin, Morshansk, Roslavl, Lyudinovo, Rzhev, Pervomaysk, Tambov, Kursk, and others.

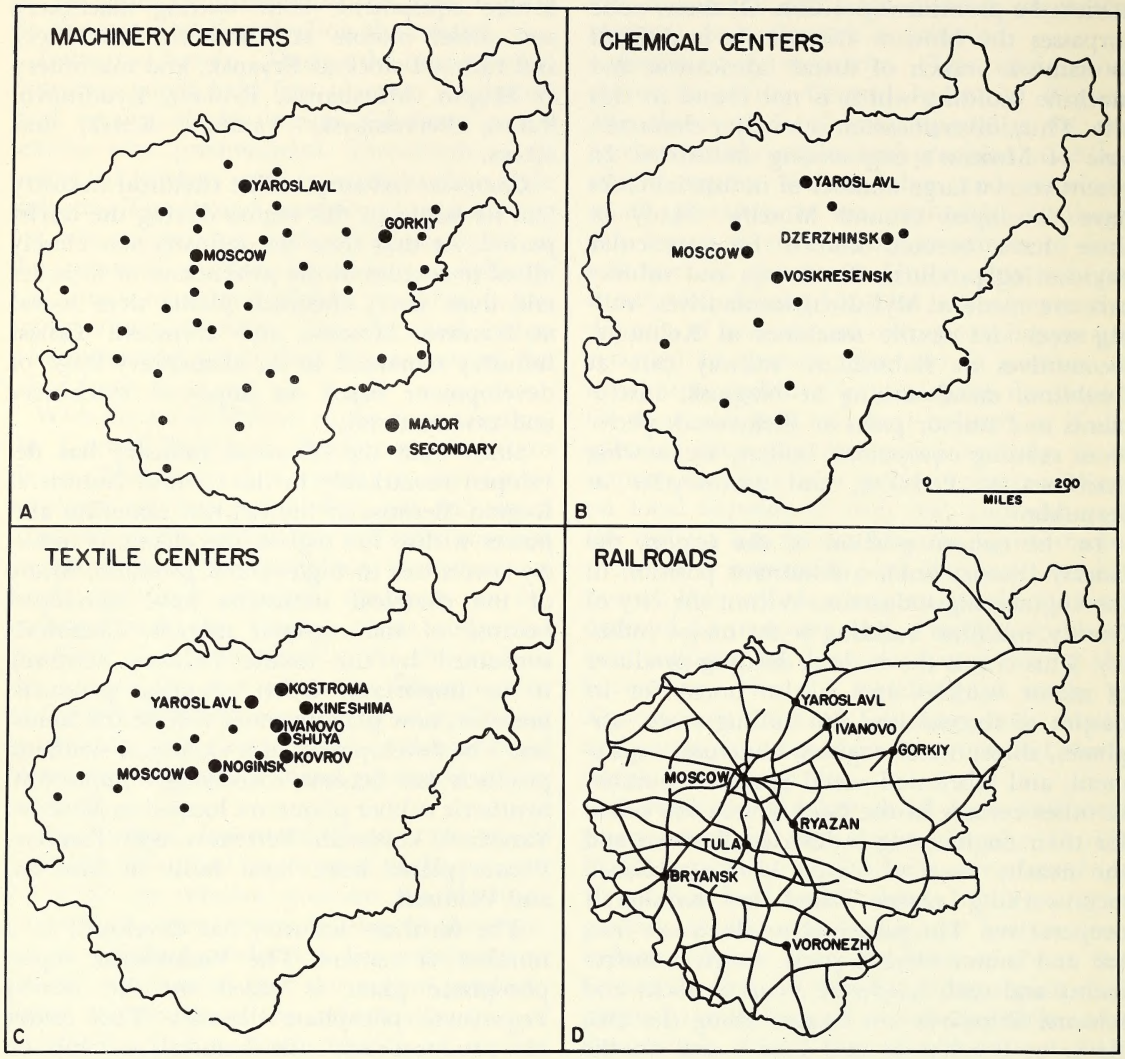
Chemical industry. The chemical industry had its origin in this region during the tsarist period. At that time the industry was closely allied to textiles in the production of bleaches and dyes. Early chemical plants were found at Ivanovo, Moscow, and Yaroslavl. Tsarist industry remained in an elementary stage of development based on imported machinery and raw materials.

Since 1928 the chemical industry has developed remarkably in the Central Industrial Region. Because of limited raw materials and power within the region, the chemical industry specializes in high-valued products. Many of the chemical industries have developed because of the regional market. Chemicals consumed by the textile industry continue to be important. Other chemical products, however, now play a greater role in the industry. The development of a variety of synthetic products has become increasingly important. Synthetic rubber plants are located in Moscow, Yaroslavl, Voronezh, Yefremov, and Tambov. Plastic plants have been built in Moscow, and Vladimir.

The fertilizer industry has developed in a number of centers. The Voskresensk superphosphate plant is based on the nearby Yegoryevsk phosphate deposits. This center also produces such basic chemicals as sulphuric acid. A second major phosphate fertilizer center is at Zavolzhye, a suburb of Kineshma, and a third is at Shchigry. Novomoskovsk, securing its fuel from the Moscow lignite basin, has a major nitrate fertilizer plant, which also produces explosives and sulphuric acid.

A wide variety of other chemicals is produced in the region. The pharmaceutical branch of the industry is concentrated in Moscow. The leather tanning industry, widely distributed, is found in such cities as Kaluga, Ryazan, Kuznetsk, Moscow, and Kursk.

Textile industry. The textile industry is one of the oldest industries of the region. Although this area has declined in relative importance with the government's attempt



4.2. Soviet Union—Central Industrial District.

to decentralize the industry, it remains the nation's principal textile region. With the development of new textile centers, such as those that are raw material oriented in Central Asia, the Central Industrial Region has increasingly specialized in the production of fine, high-grade cloth and industrial fabrics.

The Central Industrial Region has three districts and several isolated centers of textile production. In the Moscow District there is a belt of textile production extending from Moscow eastward in the Klyazma River valley to Kovrov. The textile industry in this area has developed in Noginsk, Pavlovski Posad, Yegoryevsk, Vladimir, and a number of lesser centers. To the south of Moscow is the textile center of Serpukhov. This is the major textile producing district in the Soviet Union. In the Ivanovo District the industry centers on the city of Ivanovo, the Soviet "Manchester," and includes Kokhma, Shuya, Teikovo, Rodniki, Vichuga, and Furmanov. The textile industry of this region developed initially in homes as a handicraft. During the tsarist period it was basically a one-industry region. Yet even today, although the district's industry has become

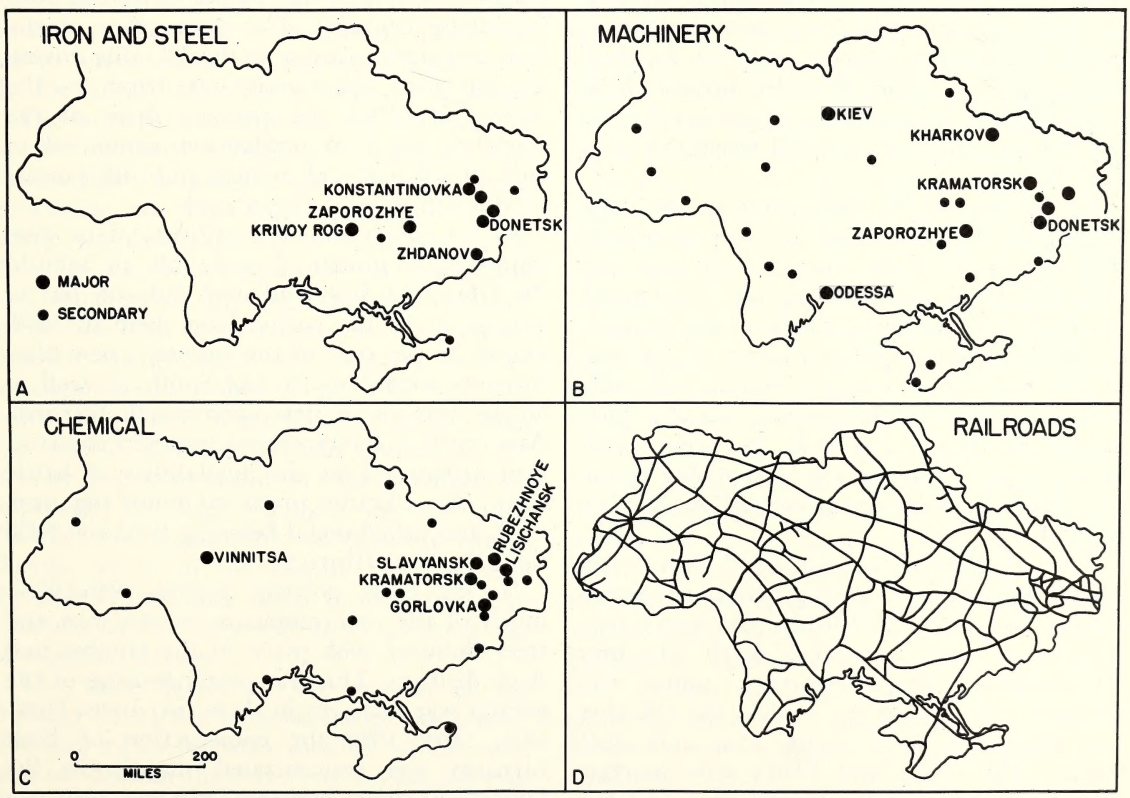
diversified, textiles play a proportionately more important role in the industrial structure of the Ivanovo District than in the Moscow District. In recent years Ivanovo has become a center for the construction of textile machinery that is marketed in the new textile regions of the Soviet Union. The third district centers on the cities of Yaroslavl, Tutayev, Gavrilov-Yam and Rostov. Unlike the handicraft origin of the industry in Ivanovo, the textile industry here developed in factories. Linen milling is the principal textile industry based on the availability of local raw materials. Isolated centers of textile production include Kostroma and Smolensk, major linen milling centers, and Kalinin, Klin, Dmitrov, and Rzhev.

Closely allied with the textile industry is that of apparel and footwear. Although many textile towns produce clothing, Moscow is the largest apparel center in the Soviet Union. This indicates the industry's orientation to the large market of the metropolitan area.

The South. The development of modern industry was relatively late in the Ukraine. Until near the end of the nineteenth century, the Ukraine was primarily an agricultural borderland of the national state which centered on Moscow. The present-day industrial economy began with the introduction of a modern ferrous metallurgical industry, and the eastern Ukraine rapidly became the "Ruhr" of Russia (7).

Development of an iron and steel industry. The first metallurgical works established in the Ukraine in 1797 utilized charcoal and iron imported from the Urals.[3] The industry remained small until the iron and steel industry became based on local resources. By 1885 the Donets coking coals and the Krivoy Rog iron ores were being effectively exploited, and

[3] McIlroy, Joseph J., *The Iron and Steel Industry of the Ukraine: A Geographic Appraisal* (unpublished Master's thesis, The Pennsylvania State University, 1959).



4.3. Soviet Union—The South.

the construction of a modest rail net was in progress to link the area with the Central Industrial Region and the Black Sea. Between 1880 and 1913 at least 19 metallurgical plants were constructed in the area. During this period the plants were concentrated in the Donbas, localized by the coking coals there. A northeast-trending line of cities centering on Donetsk and including Makeyevka, Yenakiyevo, Almaznaya, and Voroshilovsk constitutes to this day the core of the Ukraine Basin's iron and steel industry. To the south of the major center in the Donbas several plants were constructed along the Azov Sea. Here pipes and tubing for the oil fields to the east at Baku were produced, using Donets coal and iron ore from Krivoy Rog and Kerch. A third iron and steel district developed after 1885, centering along the Dnieper River. The two major sites for the new iron and steel industry, Dnepropetrovsk and Dneprodzerzhinsk, were traditionally the chief market centers for the Dnieper River-Black Sea region. These cities had skilled metallurgical workers, as small furnaces had long been operating, based on local bog iron ore and coal. Furthermore, these two cities provided break-in-bulk points for the consumption of westward moving Donets coal and eastward moving Krivoy Rog iron ore.

By the time of the Revolution in 1917, the Ukrainian iron and steel industry produced over two-thirds of the country's pig iron and over half of its steel and ferrous rolled-metal products. Of the three districts, the Donbas dominated production with about 55 per cent of the total. The Dnieper was second with nearly one-third of the output, and the Azov centers produced about 12 per cent. The influence of coking coal as a localizing factor is evident in the greater growth of the Donbas District.

The Revolution and the Civil War interrupted the economic development of the entire region. Not until 1929-30 did the area's production of iron and steel reach the pre-Revolutionary level. However, under the planned economy of the Soviets the Ukraine was designated as a major iron and steel region. The 1920's and 1930's were marked by reconstruction in the Donbas area and the installation of new furnaces in the Dnieper and Azov districts. In the interwar period, seven major metallurgical plants were built in the Donbas region: one, Azovstal, in the Azov District and six in the Dnieper District. The growth of the Dnieper District during this period is related to the utilization of the great Dnieper Dam in order to provide low-cost hydroelectric power for the electric furnaces and other alloy steel-making facilities. Because of the lack of scrap, the Dnieper District pig iron facilities were expanded to provide raw material for the growing steel industry. By 1940 the Donbas and Dnieper were each producing about 41 per cent of the iron output and the Azov District about 18 per cent. In steel production the Dnieper area had 46 per cent of the total, the Donbas 39 per cent, and the Azov District 15 per cent.

The effects of World War II on the Ukrainian iron and steel industry were devastating because the industry lay in the direct path of the German invaders. By October 1941 Russia had lost 68 per cent of its pig iron producing capacity and 54 per cent of its steel producing capacity. The destruction of the iron and steel industry in the Ukraine during the war years was a major catastrophe to the nation. By 1945 the region's share of the country's pig iron production amounted to only 19 per cent and its steel and rolled-metal production to only 11 per cent.

At the conclusion of hostilities, plans were immediately instituted, not only to rebuild the Ukrainian iron and steel industry but to enlarge it. In the period from 1946 to 1950, almost 85 per cent of the country's new blast furnaces were built in the South, as well as 58 per cent of its new open-hearth furnaces. As a result of the reconstruction and construction program, plus the availability of battle scrap, the Ukraine produced more pig iron, steel, and rolled metal between 1946 and 1950 than the Ural District.

In the early postwar period—1946-1950—much of the redevelopment of the iron and steel industry took place in the Donbas and Azov districts. This was partly because of the greater war damages in these two areas. However, after 1949 the construction of blast furnaces was concentrated mainly in the Dnieper District. Between 1949 and 1960 two blast furnaces were added at Zaporozhye, three

at Krivoy Rog, three at Dnepropetrovsk, and two at Dneprodzerzhinsk. Krivoy Rog has only become a major iron and steel producer since 1950. In the Azov area two blast furnaces were added at Zhdanov, and in the Donbas one new blast furnace was built at Yenakiyevo.

By 1956 the Dnieper and Krivoy Rog regions smelted 50.6 per cent of all pig iron in the South, compared to 29 per cent in 1913. The continued growth of the Dnieper region stems from a number of factors. The decreasing quality of Krivoy Rog iron ore requires that a larger amount of ore must be shipped to yield the same quantity of iron. Also, Krivoy Rog iron ore when hauled long distances tends to disintegrate and approaches the size of "fines." These soft, fine ores choke up a furnace and create large amounts of flue dust. This dust is blown out the top of the blast furnace and thus wasted. As the quality of ore declines, beneficiation is becoming increasingly important. Agglomeration reduces the amount of ore that has to be transported regardless of whether the operation is performed at the mine or the mill. Thus, the utilization of poorer ores has steadily increased the locational attraction of iron ore deposits.

The second factor influencing the location of the industry reflects the changing fuel economy of the Dnieper District. Substantial noncoking coal deposits have been developed within the Dnieper District, thus decreasing the district's reliance upon Donbas noncoking coal. Further, the improved utilization of coke ovens and blast furnace gases in the Dnieper District has decreased the district's relative consumption of Donbas coal. The increased availability and utilization of natural gas from the western Ukraine gas and petroleum district by recent extensions of gas pipelines have improved the fuel economy of the area. Finally, the availability of low-cost hydroelectric power in the district has decreased the district's reliance upon Donbas coal, particularly in the steel industry's growing use of electric furnaces.

The third factor in the growth of the Dnieper District is associated with the greater efficiency of its furnaces. Because of the newness of the area there is every indication that the Dnieper District's blast and open-hearth furnaces have a greater efficiency than those of the Donbas, and that the labor productivity of the former is higher than that of the latter. The fourth and final factor involves the inadequate water supply, which has retarded growth in the Donbas area. In contrast, the Dnieper area is favorably situated for supplying water to an expanding iron and steel industry. It thus appears that a series of factors has favored the expansion of the Dnieper District at a more rapid rate than either the Donbas or Azov districts.

Industrial districts. The South has developed a complex industrial structure under the Soviet regime. There has not only been a significant growth in production, but industrial regions have evolved which exhibit considerable specialization (Map 4.3). Three major industrial regions plus several manufacturing nodes can be identified. The Eastern District, extending from Krivoy Rog to Voroshilovgrad, possesses the largest concentration of manufacturing. The Central District extends from Chernigov through Kiev to Kirovograd and is oriented to the Dnieper River. On the Black Sea a belt of manufacturing extends from Odessa to Kherson, with Simferopol and Kerch as outlying nodes of considerable importance. Of the individual nodes Kharkov and Vinnitsa are notable.

Eastern District. The Eastern District accounts for more than half of the gross industrial output of the Ukraine, including more than 95 per cent of the coal, iron ore, manganese, iron and steel; about two-thirds of the machine building and metal fabrication; three-fourths of the cement; more than half of the construction materials and glass; and a large share of the chemical industry.

The iron and steel industry is the basic activity of the region. It is the foundation for the engineering industries. The great foundry centers are located in the Donbas at Kramatorsk in the northwest, Khartsyzsk in the southwest, and Lutugino in the east. The concentration of foundries not only distinguishes the Donbas from the other iron and steel sections, but also makes this area one of the foremost heavy machinery construction districts in the country. The principal Donbas machinery centers are Donetsk, Konstantinovka, Kramatorsk, and Voroshilovsk. With the development of specialty steels in the

Dnieper area, particularly in the city of Zaporozhye heavy machinery construction plants are being constructed which were formerly associated with the Donbas. The engineering products of this region include machine tools, tractors, diesel engines, rolling stock, turbines, generators, electric motors, and farm machinery.

The chemical industry of the Eastern District is well developed. It is founded primarily on the availability of by-products from the coke ovens. Therefore, it is closely associated with metallurgical centers. The area also contains salt and phosphate deposits, which have provided the basis for fertilizer and acid production. Slavyansk and Verkhneye are noted for soda chemicals. In the Dnieper District the availability of hydroelectric power has aided the production of such chemicals as nitrate fertilizers.

As the result of the availability of coal and hydroelectric power, other industries besides chemicals and ferrous metallurgy have developed in the region. The glass and ceramic industries thrive in such cities as Konstantinovka, Slavyansk, and Voroshilovgrad. In the Dnieper area the low-cost hydroelectric power has attracted aluminum and magnesium plants. Zaporozhye is noted for its nonferrous as well as for its ferrous metallurgical products.

A number of other industries are found in the Eastern District. Because of the tremendous industrial expansion the need for construction materials has created a significant industry. Of the construction industries cement holds a key position. In the region's lighter manufacturing, apparel and food processing play important roles.

Black Sea Coast. The development of industry on the Black Sea Coast has been primarily in response to its terminal position. This region possesses about 15 per cent of Ukrainian manufacturing. The leading industries are machine building, which employs more than one-third of the region's industrial labor force and accounts for one-fourth of the industrial output, and food processing, which accounts for about 45 per cent of the industrial output. The largest food processing branches are canned goods, fish, and wine. The region produces about one-third of Ukrainian cotton yarn and almost half of its cotton cloth. Some of the leading shipbuilding yards of the Soviet Union are located on the Black Sea.

Odessa, the third largest city in the Ukraine, has developed highly diversified manufacturing. Its industries include machinery, such as machine tools, food processing equipment, printing machines, and cranes; food processing, chiefly sugar, flour and canned goods; apparel and shoe factories; chemicals, including superphosphates, petroleum products, and pharmaceuticals; and woodworking and jute industries. Kherson has developed as the major port at the mouth of the Dnieper River. It is noted for its shipyards, agricultural machinery, food processing, and clothing.

On the Crimean Peninsula, the cities of Kerch and Simferopol are the leading manufacturing nodes. Simferopol is the center of an important farming district and allied manufacturing includes food processing and the production of canning machinery. Kerch is the leading heavy metallurgical center of the Crimea. It has developed an iron and steel industry based on local iron ore from the Kamysh-Burun mines six miles south of the city. Coal and coke are shipped from Zhdanov across the Sea of Azov. Besides the primary iron and steel industry, the city has coking plants and shipyards and manufactures leather goods, tobacco products, and canned foods.

Central District. The Central District, lying in north-central Ukraine, has developed a complex industrial economy. This region, including the cities of Kiev, Zhitomir, Cherkassy, Chernigov, and Kirovograd, possesses about 30 per cent of Ukrainian manufacturing. Industry within the area is diversified. Nevertheless, certain manufactural specialities have become apparent. These consist of diversified machine building, which principally includes precision items requiring small amounts of metal; food and light industries; and chemicals, particularly for agricultural consumption.

This region produces about one-fifth of the Ukrainian machinery output, including 87 per cent of the truck mounted cranes, 45 per cent of the press-forge equipment, 32 per cent of the machine tools, and a significant number of busses, motorcycles, television sets, and agricultural machinery. Kiev is the leading ma-

chinery producing center. Other machinery centers include Zhitomir and Cherkassy.

The food processing industries of this region are important, comprising about 45 per cent of the Ukrainian output. This includes two-thirds of the sugar and cheese, about 40 per cent of the meat, 35 per cent of the butter, canned goods and bakery products, and 80 per cent of the alcohol. The food processing industries of the area are directly related to the agricultural prosperity of the region.

A variety of light industries thrive, based partly on the local market and partly on available raw materials. Two-thirds of the leather goods and 50 per cent of the footwear made in the Ukraine are produced in the Central District. This reflects the availability of hides from the large cattle industry. About 45 per cent of the knitted goods and hosiery made in the Ukraine are produced in Chernigov, Kiev, Zhitomir, and Kirovograd. This area also has about two-thirds of the output of the timber, woodworking, furniture, and paper industries in the Ukraine.

Outlying nodes. Of the isolated nodes of manufacturing, Kharkov plays an important role. It is situated at the junction of six railroads at the northern gateway to the Donbas and Dnieper districts. The industry of this city developed rapidly in the late nineteenth century. Its excellent transportation facilities provide easy assembly of raw materials and access to a wide market in the Ukraine. It now produces a variety of industrial products such as farm machinery (including tractors), electrical machinery, machine tools, locomotives, turbogenerators, ball bearings, precision instruments, cables, bicycles, glass, and paper. It also has light and food industries.

Lvov is the largest city of western Ukraine and the hub of eight railroad lines. Its industry has grown to serve the regional market. Its manufacturing includes such metalworking industries as agricultural machinery, railroad and printing equipment, automobile assembly, and electrical goods. There is a small petroleum refining industry based on petroleum from the western Ukrainian fields. Other manufacturing includes glass, chemicals, leather and textiles.

There are a large number of food processing centers in the Ukraine. Of these, one of the largest is Vinnitsa. Its economy is closely allied to the regional agriculture with plants producing sugar, flour, meat, and alcohol. It also has a superphosphate plant.

Leningrad industrial node. Leningrad was one of the earliest industrial centers of Russia. It is said that industry in this city was founded upon British coal and iron and Russian wool. Although the area had few local industrial resources, its position as the major port of northwestern Russia gave it an early transportational advantage in the assembly of foreign raw materials. The land transportation system of northwestern Russia also had an orientation toward Leningrad. Coal, iron, and jute were imported and Russia's own coal and iron were shipped partly by land and partly by water routes to the area. The city early became a focal point of Russian trade and commerce. As a consequence a group of diversified industries grew, and today Leningrad produces about 10 per cent of the total Soviet industrial output.

Because of accessibility to raw materials, a skilled labor supply, and a market, Leningrad became one of the earliest machine building centers in Russia. This industry was well established during the tsarist period, and Leningrad played a vital role in the industrialization of of the country during the first five-year plan. Its well-equipped plants and skilled workers were utilized to introduce the manufacture of machinery into other areas of the Soviet Union. The emphasis on production of engineering industries has been maintained during the Soviet regime. The products produced in Leningrad include machine tools, steam turbines, rolling mills, textile machinery, scientific instruments, printing presses, telephones, diesel engines, electrical equipment (including turbines, generators, transformers, and high frequency installations), tractors, and motorcycles. Leningrad is one of the few producers of large hydroelectric turbine installations in the Soviet Union. It is also one of the production centers for the more complicated machine tools.

In response to its international trade position, Leningrad is a Soviet shipbuilding center. This industry dates from pre-Revolutionary Russia. The Baltiykiy yards are the largest,

and in recent years they have produced a number of specialty vessels. Of these, the production of oil tankers reflects the increased supply of petroleum in Russia and the need to develop international markets. The largest tankers are about 600 feet in length and are designed to carry various kinds of oil products simultaneously. Other specialty vessels include refrigerator ships and whaling vessels.

Besides the diversified engineering industries, other types of manufacturing have developed in the Leningrad area. An important chemical industry dates from the tsarist period. Pioneering efforts of Leningrad chemists resulted in the initial development of the method for producing synthetic rubber from potato alcohol. The area is now noted for caustic soda, reagents, paints, cosmetics, and drugs. A superphosphate fertilizer industry dependent upon apatite from the Khibiny Highlands is of importance. The textile industry was also an early industrial endeavor and still occupies a prominent position. About 10 per cent of the cotton cloth production of the U.S.S.R. originates in the mills of the city. The city also possesses a large number of consumer goods factories.

The Leningrad area consumes large quantities of power (16). During the tsarist period power was obtained primarily from imported coal. With the coming of the Soviets coal is supplied from the Donets. Petroleum from the new Volga-Ural fields is providing a greater share of the energy consumed. Because these domestic sources of fuel are distant there has been the desire to develop local sources of power for Leningrad industry. Large-scale electric power plants have been constructed in the area. Peat consuming power stations are located near Leningrad, while hydroelectric stations have been erected on the Volkhov and Svir rivers.

The Leningrad type of industry has developed in a number of industrial suburbs. To the east Petrokrepost has cotton mills and a chemical plant producing explosives. Volkhov, on the Volkhov River, was in 1926 the site of the first large hydroelectric power plant constructed by the Soviets. As a response to the low-cost hydroelectric power and the availability of bauxite from Boksitogorsk, it has become a center for aluminum production. Cement is also produced in Volkhov. To the south of Leningrad are such industrial cities as Kolpino, Pavlovsk, Pushkin, and Gatchina, which produce machine tools, pulp and paper, steam engines, steel rolling equipment, apparel, and chemicals.

Outside of Leningrad and its suburban industrial cities, manufacturing in the northwestern portion of the Soviet Union has gained little importance. Pulp, paper, and woodworking plants are located in a number of places such as Novgorod, Borovichi, Novaya-Ladoga, Vyborg, Pitkyaranta, Lyaskelya, and Sortavala. Glass products are also produced in a number of centers. A fairly heavy concentration of industry occurs in northern Estonia at Narva, Kokhtla-Yarve, and Tallin. The manufactured goods in these centers include machines, fertilizers, cement, paper, textiles, and petroleum products.

Middle Volga Region. The Industrial Revolution long bypassed the Middle Volga Region (15). In the nineteenth century this area possessed a backward agricultural economy. At this time not more than 5 per cent of the population was engaged in industry, and handicrafts were much more important than factory output. Local raw materials provided the basis for flour milling, tanning, distilling, and preparation of other consumer goods. Besides agricultural processing there were also such small industries as shipbuilding, timber, and cement. In terms of value, Saratov, the center of a German settlement, was of greater importance than either Samara or Kazan.

The early years of the communist regime witnessed little change in the traditional economy of this region. In 1926, when severe drought brought famine to the area, the economy was still soundly based on agricultural pursuits. The general lack of industry here was predicated on a number of seemingly adverse factors. Apart from minor deposits of shale and asphalt at Syzran, no minerals, metals, or industrial fuels were known to exist in the region. During the early period it was thought that the Volga River could not be harnessed to provide electric power. Not only was there a gentle gradient in the flow of the river but summer drought and the long period of winter ice were considered insurmountable handicaps. The river also was not considered a water

route because of shallowness in summer and ice in winter. Because of the smallness of industry the area also lacked other prerequisites, such as a large and skilled labor force.

With the development of the first five-year plan in 1928 emphasis was placed on reorganizing the agriculture of the region. As a result, the demand for agricultural machinery provided the impetus for the establishment of metalworking industries by the mid-1930's. However, by the end of the second five-year plan in 1937 the Middle Volga still had essentially no power resource development. The Moscow-Volga canal was being completed, but the Don Canal connecting the region with the Ukraine was still not in existence. The railroad lines maintained their east-west orientation so that the cities along the Middle Volga were essentially isolated from one another.

In the latter part of the 1930's as war threatened in Europe, the Soviet government accelerated the policy of moving industry eastward. This was the first incentive for the growth of an industrial complex in the Middle Volga Region. Since then the rate of industrial growth has continued to increase.

The change from a backward agricultural region to an industrially dominated area has occurred through a number of factors. Of these, none is more significant than the new availability of power resources. This area has become the leading power center of the Soviet Union. During the early 1940's petroleum was discovered in the Volga-Ural province under the impetus of exploration from war demands. As a result of intensive drilling there has been a phenomenal increase in production. By 1950 the Volga-Ural fields produced about 25 per cent of the nation's total. By 1960 the region's proportion had increased to nearly three-fourths. Moreover, it is estimated that this region possesses about four-fifths of total Russian reserves. In the past, coal was the primary power source in the Soviet Union, supplying about two-thirds of the total. With the increasing availability of petroleum the Soviet aim is to reverse this proportion. By 1972 oil is to supply over two-thirds of Soviet fuel demands.

Within the Volga-Ural oil province the fastest growing oil area centers on the Middle Volga. Of the oil fields, that of Tatar near Almetyevsk surpasses the production of the Baku area. Another production zone is found astride the Great Volga bend near Kuybyshev and Syzran. This region has become the principal source of oil for the Soviet Union. In 1946 a pipeline was completed to Moscow and other cities of the Central Industrial Region. To the east a 2,000-mile pipeline has been built to the Baikal industrial area. Oil is also distributed by barge and tanker.

Although oil is primarily responsible for providing the power base for the present industrial expansion, the development of hydroelectric power under the Great Volga Scheme is of significance. A series of dams are planned to store water for irrigation and to control the seasonal flow. The first small dams were completed in the early 1940's, but it was not until 1954 that the major postwar developments became evident. In this year the dam and power station were completed above Perm on the Kama, followed by major dams above Gorkiy at Gorodets and, in 1958, the giant Kuybyshev Dam at Zhigulevsk. The Kuybyshev Dam is one of the largest in the world and in 1960 provided one-fifth of Soviet hydroelectric power. Electricity is sent from this dam to the Urals and the Central Industrial Region, and it plays a major role in the establishment of the western Russian hydroelectric network. When the Great Volga Scheme is completed there will be a continuous series of dams along the Volga from north of Moscow to Volgograd (Stalingrad) and on the Kama south of Solikamsk.

A third factor in the industrial transformation of the region is the growth of the transportation system. Besides the north-south water route provided by the Moscow-Volga canal, the development of the Don Canal connects the Volga region with the heavy industrial regions of the Ukraine. The Don Canal brings needed access to iron and steel and other heavy industrial materials by low-cost water transportation. The railroad network has also been strengthened by the construction of north-south lines connecting the cities of the region. As a result of new transportational developments the region has become readily accessible to other areas in Russia.

As a response to the available power resources of the region, a group of industries has evolved. The petroleum industry has created

a demand for a wide variety of products, including drilling and pumping equipment and excavation. The availability of petroleum has provided the raw material for petroleum refining. From this industry has come a wide range of derivatives including synthetic rubber and fibers, alcohol, and fertilizers. The development of hydroelectric resources has created a market for such industrial products as cement and hydroturbines. Besides the industries oriented to Volga raw materials and enterprises, a wide variety of others, particularly in the field of engineering, have developed in the area.

Within the region the Kuybyshev-Kazan area has evolved as the leading industrial district. Since 1940 the Kuybyshev Oblast has experienced the most rapid growth in the nation. Of the Middle Volga cities, Kuybyshev-Kazan area is most favorably situated on transportation routes from the Urals to Moscow. This area is noted for its output of automotive and railroad equipment, chemicals and construction materials such as cement, brick and glass. During World War II the production of airplanes and motors, ball bearings, motor vehicles, and cables was also begun. Agricultural industries process local raw materials, producing flour, alcohol, starch, meat, candles, soap, and others. Sawmills, match factories, and paper plants are based on available timber.

Volgograd, developed as a river port and rail center, became a manufacturing center in the 1930's. Its early industry was related to the agriculture of the immediate region. The manufacture of tractors is the largest new branch of industry. It is represented by the Volgograd Tractor Plant, which played a major role in altering the traditional pattern of agriculture in the Volga area. The famous "Red October" metallurgical works are also located in the city. Within recent years the refining of petroleum has been increasingly important, along with associated chemical industries. A lumber industry also thrives. Krasnoarmeysk, a suburb of Volgograd, produces ships for the Volga River traffic.

Saratov is the main industrial city of the Saratov Oblast. This center has metal works, textiles, and lumber mills. Smaller industrial cities include Marks, which produces agricultural machinery, clothing, tobacco, knit goods, and food products. Krasnoarmeysk has textile mills and shoe factories and Kamenskiy manufactures tractors.

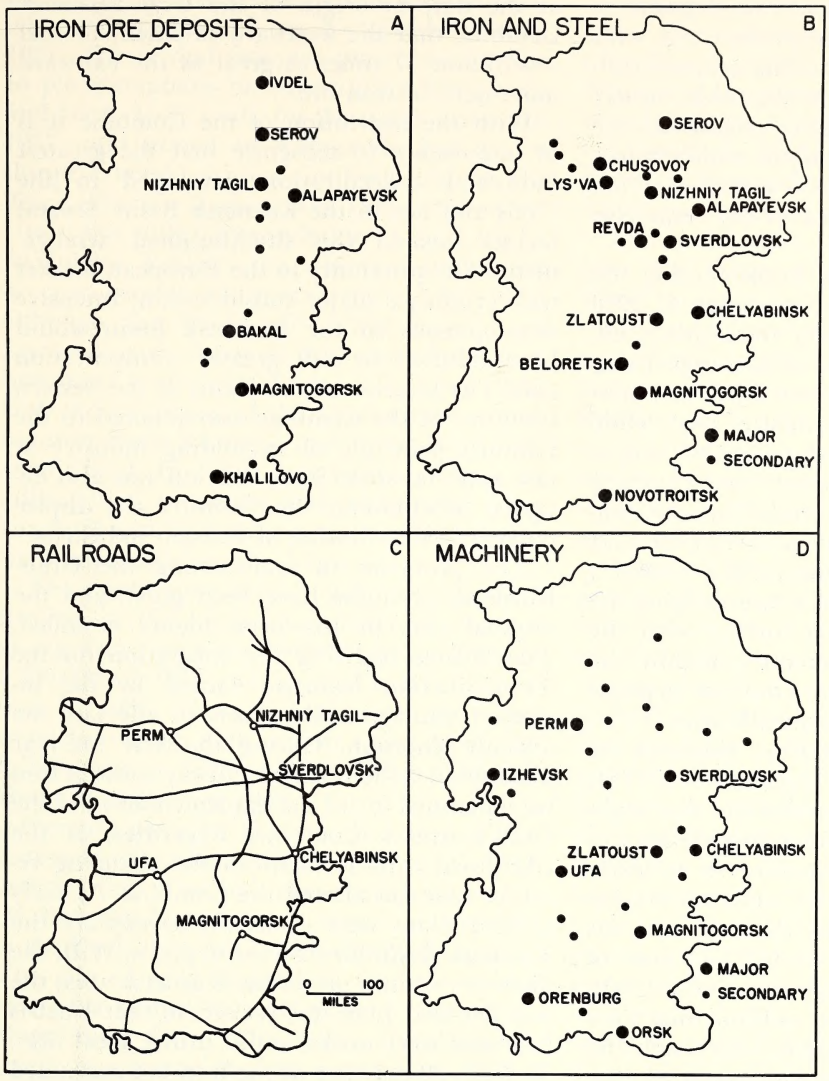
The Urals. The Ural Region is situated in the southern two-fifths of the Ural Mountains. This area has traditionally been the divider between European and Asiatic Russia. The movement eastward in the sixteenth century crossed the region, and since then the low passes in the Urals have provided the major routes to Siberia.

Development of industry. The development of industry in the Urals dates from the eighteenth century when Tula was no longer able to supply sufficient iron for the guns and ammunition of the Russian armies. The first ironworks were built in the Urals in 1701. The industry grew slowly and by 1800 the Urals had a cast iron production of 130,655 tons, out of the Russian total of 163,376 tons. The iron output of the Urals at that time was about 80 per cent of the Russian total.[4]

The early development of the iron industry in the Urals was based on a number of advantageous factors. The presence of essential raw materials gave the area an advantage. Charcoal was obtained from the forests that predominate in the northern portion of the region, and iron ore was worked from deposits at Mount Blagodat, Vysokaya, and a few lesser places. The industry was encouraged by the tsars who made land grants to enterprising noblemen and members of the merchant class in return for development of the iron industry. By the beginning of the nineteenth century a definite distributional pattern existed that was little altered until the advent of the first five-year plan in 1928. Production was heavily concentrated in the northern portion of the area with Nizhniy Tagil the major center.

The Urals remained dominant in Russian iron production until after 1860; then a general relative decline began. In 1860 the area produced 237,500 tons of pig iron, or 82 per cent of the Russian total. By 1877 output had increased to 263,802 tons, but this was only 65 per cent of the Russian total. The relative decline was primarily in response to the tech-

[4] Pred, Allan R., *The Urals Iron and Steel Industry: A Geographical Analysis* (unpublished Master's thesis, The Pennsylvania State University, 1959).



4.4. Soviet Union—The Urals.

nological change in fuel from charcoal to coke in the iron industry. The lack of coking coal in the Urals proved a critical factor in its decline during this period. The percentage share of the Urals decreased from about two-thirds in the 1870's to 28 per cent in 1900. At the same time the iron output of the Ukraine rose from 0.1 to 51 per cent. The downward trend in relative importance continued until the first five-year plan was inaugurated.

The iron produced in the Urals during the tsarist period was primarily exported westward to the Moscow industrial area. There is no evidence that mechanical industries were attracted to the area by the availability of a raw material. The isolation of the region, the limited local market, and the poor transportation facilities retarded industrial growth.

Soviet implementation of an iron and steel industry. Under the communist plans for expansion of Russian industry, the Urals were among the first regions to be developed. In 1928 the Urals were farthest east of the existing industrial areas and were the best situated to serve Siberia. At the same time the existing metallurgical industry was technologically primitive, and could not serve as the founda-

tion for a modern industry. Vast deposits of iron ore were known to exist in the Urals, with the largest at Magnitogorsk. The nearest available coal resources were at Kuznetsk, nearly 1,500 miles to the east. Thus originated the famous Urals-Kuznetsk Combine which visualized the eastward movement of iron ore and the westward movement of coal to the respective regions.

The initial steps toward implementing the Combine were taken on September 4, 1928 when preferential rail rates were instituted. The rate for the shipment of Kuznetsk Basin coals westward was to be one-third that normally charged for the shipment of coal, while the rate for the eastward shipment of Magnitogorsk ores was to be one-half that regularly imposed on iron ore. The Urals-Kuznetsk concept became a legal reality when the Central Committee of the Communist Party passed a resolution on May 15, 1930 acknowledging the impossibility of proceeding further with the industrialization of the country within the limitations of the coal and iron ore deposits utilized up to that time in the Ukraine.

The first coal shipment from Kuznetsk arrived in Magnitogorsk on September 10, 1931, although officially the Combine did not begin until early 1932. In order to gain some idea of the functioning of the Combine in its early years, the movement of coal and iron ore for 1933 is analyzed here. In that year it was planned to ship 11 to 12 million tons of Kuznetsk coking and energy coal to the Urals. Of this amount 3.3 to 3.6 million tons were designated for Magnitogorsk. Although no data are available on the fulfillment of that objective, it appears that Magnitogorsk received the planned amount. This assumption is based on two considerations. The other small industrial centers of the Urals, such as the iron and steel plant at Nizhniy Tagil, had to be supported by coal coming from the Kuznetsk; second, about 40 per cent of the Kuznetsk coal was consumed in its own transportation. In the same year, it is estimated that 650,000 tons of Magnitogorsk ore were shipped to the Kuznetsk. Such an estimate is based on the fact that the Kuznetsk area produced 390,000 tons of pig iron in 1933, and the entire production was based on ores imported from the Urals. It is thus evident that at the time of origin of the Urals-Kuznetsk Combine that the westward shipment of coal was almost 17 times as great as the eastward movement of iron ore.

With the institution of the Combine it is of importance to recognize that the greatest industrial concentration developed in the Urals and not in the Kuznetsk Basin. Several factors favored this distributional arrangement. The proximity to the European market was certainly a major consideration. Intensive developments in the Kuznetsk Basin would have resulted in still greater transportation costs.The location of the plants at the western terminus of the Combine also adhered to the Leninist principle of expanding industry at raw material sites. Such location was also designed to eliminate "the century old disproportion in distribution of Russian industries."

The problems of maintaining the Urals-Kuznetsk Combine have been great, and the original concept has been highly modified. The Soviets realizing the congestion on the Trans-Siberian Railroad caused by the increased tonnage made efforts to alleviate the difficult situation. During the first five-year plan about 2,050 miles of railway construction were planned to aid the implementation of the Urals-Kuznetsk Combine. Regardless of the additional railway facilities the changing resource base has altered the Combine. As early as 1931 plans were underway to explore the Kuznetsk Basin for iron ore deposits. With the discovery of iron ore in the Kuznetsk area, the first five-year plan was revised so that Kuzbas iron and steel works would utilize local ores. By 1937, 30 per cent of the iron ore consumed by the Kuznetsk iron and steel plants was mined locally. The third five-year plan called for a reduced movement of ferrous ores from Magnitogorsk to Kuznetsk, and in 1941, the transport difficulties reached such proportions that, in order to encourage the maximum use of local ores at Kuznetsk, the special rate on Magnitogorsk ore was removed. After 1945, with the decline in reserves of Magnitogorsk ore becoming more fully realized, Kuznetsk consumption of local ores increased rapidly. In the sixth five-year plan, begun in 1956, it was planned to reduce the ore movement from the Urals to the Kuznetsk as much as possible.

In the early stages of the Combine an alter-

native coal source for the Urals was obtained with the opening of the Karaganda field in 1931. The second five-year plan was the first to place emphasis on substituting Karaganda and local Ural coals for Kuznetsk coals. In 1937, coal mined in Karaganda had to be shipped north to the southern leg of the Trans-Siberian Railway and then west to the Urals; but with the completion of the Kartaly-Akmolinsk Railway the westward movement of coal became more economical. By 1939, although the Urals still relied heavily on Kuznetsk coal, about 25 per cent of the coal consumed came from Karaganda. Since 1945 with the expansion of the Urals metallurgical industry, both Kuznetsk and Karaganda coals are utilized. In 1960, it is estimated that 20 million tons of energy and coking coal from Kuznetsk and 10 million tons from Karaganda were imported into the Urals.

The production of iron and steel has risen steadily in the Urals since 1928. Production of pig iron rose from 700,000 tons in 1928 to 7,300,000 in 1950 and approximately 15 million in 1960. In steel production the same trend is evident, with output rising from one million tons in 1928 to 11,900,000 in 1950 and about 25 million in 1960.

Present pattern of manufacturing. The ferrous metallurgical centers of the Urals have become the principal manufacturing nodes. Of these the Magnitogorsk District is the core of the Urals iron and steel industry (Map 4.4). The city of Magnitogorsk is situated at the base of a mountain of high-grade iron ore—Magnitnaya Gora. This heavy metallurgical center was created by the communists in the early 1930's in an essentially uninhabited forest region. Within a few years a huge metallurgical complex of blast furnaces, coke ovens, steel works, rolling mills, and electric power plants evolved. By the beginning of World War II the Magnitogorsk plants alone produced more iron and steel than the total Ural output during the tsarist period.

The development of the iron and steel industry at Magnitogorsk is oriented to the local iron ore deposits. This industry, the largest consumer of coking coal in the Urals, secures about 65 per cent of its coal from the Kuznetsk area and 35 per cent from Karaganda. The manganese is obtained about 50 miles to the northwest in the Bashkir A.S.S.R., particularly from the Abzelilovo and Beloretsk areas. Chromite is secured from Kempirsai. Local deposits of limestone exist. The Magnitogorsk plant produces a complete range of iron and steel products. Within the area are eight blast furnaces, 28 open-hearths, and 14 rolling mills. There are ten coke-oven batteries.

The availability of steel has provided the base for metal consuming industries (24). These products include machine tools, railway rolling stock, tractors, motor vehicles, mining equipment, and heavy machinery. A chemical industry based on coal by-products produces fertilizer and a host of other products. Because of the demands of heavy construction the cement industry has thrived. Other industries of importance include textiles, clothing, shoes, and foodstuffs.

North of Magnitogorsk lies the old tsarist provincial town of Chelyabinsk. With the construction of the Trans-Siberian Railroad in the 1890's this city gained importance as the "Gateway to Siberia." During the tsarist period it developed food processing industries, particularly flour milling. It was not, however, until the Soviet period that a metallurgical industry was established in the district. Ferroalloy production began as early as 1931, but it was not until 1944 that the first blast furnace began operation. This has become one of the most rapidly growing cities and is now the second largest industrial center on the eastern slopes of the Urals. Its growth has been based on a number of factors. The primary iron industry uses local Bakal ores. The ferroalloy plant, which is the largest in the Soviet Union, produces ferrochrome, ferromanganese, ferrosilicon, silica-alumina, and other ferroalloys. The city, with five rail lines intersecting, is a focal point. This facilitates the importation of Kuznetsk and Karaganda coal and the distribution of finished goods. Because of the availability of high-quality steel, Chelyabinsk is noted for its specialty engineering industries. Among the manufactured products are tractors, aircraft, machine tools, watches, agricultural and road building machinery, abrasives, and chemicals.

To the west of Chelyabinsk, the city of Zlatoust represents the dispersal of industry in the Urals. This is primarily a steel and

machinery producer. The Zlatoust plants are not localized by iron ores. The steel plant depends to a large degree on the availability of scrap. Some Bakal ore is utilized as well as pig iron from Chelyabinsk. This center is noted for its quality steels and castings, and the manufacture of machine tools, agricultural machinery, cutlery, chemicals, construction materials, lumber products, and foods.

In the central Urals, Sverdlovsk forms an economic and cultural hub, and is also a metallurgical center. Besides possessing a primary metals industry its heavy machinery industry produces mining, chemical, drilling, and metallurgical machinery. Electrical equipment is manufactured from metal produced at the local Verkh-Iset mill, and from the copper refineries at Verkhnyaya Pyshma and Revda. The city also has plants producing television sets, aircraft motors, machine tools, ball bearings, chemicals, wood pulp, paper, clothing, and food products.

In the northern portion of the region, Nizhniy Tagil is one of the old iron centers that has been reconverted into a modern industrial metropolis. The steel plant built during World War II is said to be approaching the size of the one in Magnitogorsk. The primary iron and steel industry is based on iron ores from Mount Vysokaya and Mount Lebyazhye, just west of the city, and also from the Alapayevsk deposits. The plant gets its coking coal from the Kuznetsk, but also uses Kizil noncoking coals and lignites from the Bogoslovsk field. As other metallurgical centers in the Urals, Nizhniy Tagil is noted for its machinery production, and has developed a major chemical industry based on by-products from the coke ovens. The area is also noted for its wood industries, cellulose production and cement output.

In the western Urals the development of the oil industry has aided the industrialization of the region. The small oil fields of Kama and Belaya have been producing for decades. Significant new discoveries were made prior to World War II, but progress was relatively slow until after 1945. The western Ural fields now produce over half of the Soviet oil output. As a result the leading industry in the western Urals is the refining of oil and the associated petrochemical industry. The largest processing centers are Perm, Krasnokamsk, Ufa, and Ishimbay.

The industry of the Urals is becoming widely dispersed. Many of the smaller cities are now important industrially. In the western Urals, Chusovoy is the most important metallurgical center. Major machinery centers have developed at Orsk, Orenburg, Ufa, Izhevsk, and Perm. Alapayevsk is a steel milling center and in recent years the development of nearby bauxite deposits and hydroelectric facilities has laid the foundation for an aluminum industry.

Kuznetsk Basin. The most striking industrial development in Siberia has occurred in the Kuznetsk Basin with the creation of a huge industrial complex. This region has been developed during the Soviet regime. It came into existence under the implementation of the Urals-Kuznetsk Combine. The first plant to be developed after the 1930 decision to industrialize the area was the Novokuznetsk iron and steel works on the banks of the Tom River, opposite the old trading center of Kuznetsk. This plant began operation in 1932.

The iron and steel industry was oriented to the coal fields of the Kuznetsk Basin. This coal basin is, next to the Appalachian in the United States, the richest in the world. However, the coking coal is limited and in recent years there has been the necessity to utilize lower-grade coals for coking. Within the area are six important coking coal regions: Anzhero-Sudzhensk, Kemerovo, Leninsk-Kuznetskiy, Kiselevsk, Prokop'yevsk, and Osinniki. These coals yield good-quality, low-sulphur coke.

The original plan visualized that the iron ore for the plant would be secured from the Urals area. However, almost immediately exploration was begun in the area to discover local iron ore deposits. The Soviets have had some success in this undertaking. Until 1939, the only local iron ore came from the Mount Tel'bes deposits, 50 miles west of Novokuznetsk. This deposit, supplying 20 to 30 per cent of the demands of the Novokuznetsk plant, was depleted in the early 1940's. In 1939 a second deposit was developed at Temir-Tau, which is still the most important local source of ore. This is a magnetite deposit, averaging 45 per cent iron. The greatest problem in utilizing this deposit is its zinc sulfide

impurity. The zinc sulfide is reduced in the furnace to zinc oxide, which precipitates on the furnace wall working its way between bricks and causing cracks, disintegration, and holes. As a consequence, other deposits have been sought, resulting in discoveries at Tashtagol, Orda-Bash, Shalym, Sheregesh, and Kochura. At present 70 to 80 per cent of the iron ore utilized in the Kuznetsk iron and steel industry is produced within the region. The remaining 20 to 30 per cent comes from the Magnitogorsk and other ores of the Urals. Because of the relatively poor quality and low reserve status of Kuznetsk ores, the expansion of the iron and steel industry has been handicapped.

The production of iron in the Kuznetsk area has risen from no production in 1930 to 1,500,000 tons in 1940, 1,800,000 in 1950, and over two million in 1960. Steel production has demonstrated similar trends rising to 1,800,000 tons in 1940, 3,100,000 tons in 1950 and to over five million tons in 1960. This is approximately 7 per cent of Soviet output.

Primarily as a response to the availability of iron and steel from Novokuznetsk and the general development of the economy of the region, an industrial zone has been created in the triangle of Novokuznetsk, Kemerovo, and Novosibirsk. Besides iron and steel, Novokuznetsk is noted for its production of chemicals, locomotives, rolling stock and building materials. Novosibirsk is the largest machine building center but also possesses chemical, farm machinery, textile, nonferrous metallurgy, and woodworking plants. On the basis of coal production at Kemerovo, an important coking and chemical industry has arisen in the city. By-products from the coking ovens and sulphuric acid from the nonferrous metallurgical works have laid the foundation for a fertilizer industry. Belovo processes zinc ore from the Salair mines in its vicinity, and also produces building materials, electrical equipment, and other engineering products.

Caucasus. The Caucasus area has a long history of handicraft production. The high mountains of the region isolated the area, making industrial developments difficult. The first modern industry developed in the area with the discovery of petroleum in the early 1860's. This was the Soviet Union's first oil region, and the petroleum refining industry dates from this period. Oil is the single greatest resource of this region and until the early 1940's this area possessed the largest oil field in Russia. Most of the refineries of the region are oil-field oriented, such as those at Baku, Grozny, Tbilisi, Mirzaani, Makhachkala, and Krasnodar. The refineries at Tuapse and Batum on the Black Sea illustrate a break-in-transportation location for marketing the Caucasus oils in the Ukraine. Because oil production in this region has been declining in recent years, there has been little if any growth in the oil refinery capacity of the area. Actually, in order to maintain the refining industry petroleum from the Volga-Ural fields has been brought to these refineries for processing.

Besides petroleum, the Caucasus area is an important storehouse of metallic minerals. Under the Soviets these minerals are being exploited. The availability of magnetite iron ore, manganese, cobalt, and coal has provided the foundation for a new iron and steel industry at Rustavi. This location reflects a mid-point between the coal deposits at Tkvarcheli, about 200 miles to the northwest, and the iron ore deposits at Dashkesan, about 75 miles to the southeast. The iron and steel plant is approximately 25 miles from Tbilisi, one of the major markets for iron and steel in the area. To reach the iron ore in the mountains an electric railroad has been built from the main line to the Dashkesan area, where an industrial mining town has been built at an elevation exceeding 5,000 feet. A second small iron and steel center is located at Sumgait. This plant uses Dashkesan iron ore and its principal product is pipe, primarily for the oil industry at Baku.

A chemical industry in the region is based not only on petroleum, but deposits of sulphur, pyrites, and salt. Baku is the region's principal petrochemical center. Other petrochemical centers include Stavropol, Makhachkala, and Sumgait. Kirovakan and Yerevan are noted for production of nitrate fertilizers. The development of this industry has been encouraged by the expansion of the hydroelectric power facilities in the Caucasus. There are now 14 large hydroelectric installations in the area. Sulphuric acid is produced at Kutaisi and Kirovabad.

The commercial agriculture of the region has also developed. The valleys of the mountainous country are rich agricultural areas and the products are processed at a number of centers. Cotton is a leading crop in the southern portion of the region and cotton growing is widely dispersed. The production of silk is also advanced in the western portion of the region. Primarily as a response to availability of raw materials, the textile industry has developed throughout the area. Notable centers of textile production include Kutaisi, Kirovabad, and Tbilisi. Other agricultural processing in this region includes oil presses, fruit and vegetable canneries, flour mills, and tobacco factories.

With the development of the area's primary resources a demand has been created for a wide variety of manufactured products. Of these, none is more important than those provided by the engineering industries. Machinery production, although still relatively small, has developed in a number of centers. Tbilisi now produces lathes, oil drills, electrical goods, and textile, tea, and wine making machinery. Kutaisi produces trucks and coal mining equipment. Baku is noted for oil drilling equipment and ball bearings, and also possesses a small shipbuilding industry.

Central Asia. The Central Asian area, centering on the cities from Dushambe (Stalinabad) through Tashkent to Alma-Ata, has developed modern industry under the Soviet regime. The industrial development of the region is closely allied to the regional economy. Because of the isolation of the region there is a need to produce industrial products demanded locally. At the same time the distance to other markets in the Soviet Union has handicapped the area in producing for national consumption.

Because of the rich agricultural valleys, Soviet planners have stressed the development of a highly specialized zone of commercial agriculture in Central Asia. Of the crops produced, cotton has the highest priority. In turn the industries associated with the production of cotton have had a major influence on the industrial structure of the region. Throughout the area are cotton gins and plants for the production of cotton by-products such as cottonseed oil and cake. It is estimated that the Uzbek Republic possesses 62 per cent of the cotton gins in the Soviet Union. Primarily as a response to the available cotton and the local demands for cloth, a cotton textile industry has developed in the region. Tashkent, Fergana, Samarkand, Alma-Ata. Kandaz, Uch-Kzyl, and Dushambe are the leading centers. Of these, the largest textile plant is in Tashkent, where 20,000 workers are employed in the spinning and weaving of cotton in an integrated industrial combine. This is also the silk producing region of the Soviet Union, and wool from sheep grazing on the semiarid lands has provided the basis for a woolen textile industry.

Other industries have developed which serve the agricultural economy. One of the most important of these is the production of mineral fertilizers. The largest nitrogen fertilizer plant in the Soviet Union is the Chirchik Electro-Chemical Combine located northeast of Tashkent. Besides fertilizers the plant produces related chemicals and chemical machinery. The availability of hydroelectric power localized this plant. A second nitrogen fertilizer plant is situated at the lignite mining center of Angren, east of Tashkent. Superphosphate plants are located in Samarkand, Kokand, and Dzhambul. An agricultural machinery industry is also developing in the region. The primary center for this industry, as well as other machinery, is Tashkent. Emphasis is placed on the production of machinery for the planting, cultivating, and harvesting of cotton. Food processing is increasing in importance. Sugar beets are grown in the irrigated valleys and sugar refineries are located at Tokmak and other places. Flour mills are scattered throughout the region.

The mineral wealth of the region is also providing a basis for the development of manufacturing. In 1943 the first iron and steel industry in Central Asia was built at Begovat, in order to utilize local supplies of scrap. At the time the plant was built the local raw material base was extremely weak. The project, however, was promoted in the fourth five-year plan for development into an integrated iron and steel works. As a result of this stimulation, an intensive exploratory program was initiated for local coal and iron ore deposits. A large number of coal deposits

have been discovered, of which several are coking coals. The major coking coal area is at Kyzyl-Kiya, in Kirghizia at the southeastern end of the Fergana Valley. Numerous iron ore deposits have also been discovered in Central Asia. These deposits vary from 40 to over 150 miles from Begovat. Although the known deposits are relatively small, they will support a small primary iron and steel industry for several decades. This plant now provides the iron and steel for the expanding engineering industries of the region.

Other minerals in the area have fostered industrial establishments. Important chemical works are operating at Shorsu based on local sulphur and ozocerite deposits. A lead smelter and refinery has been built at Ak-Tyuz to process local ores. The expansion of petroleum production in the western portion of the Turkmen Republic since World War II has led to the growth of a petroleum refining industry. Fergana and Nefteabad are important refining centers. The area now has an excess of petroleum products that are shipped outside the region.

The industry, originally developed to supply the regional market, is now beginning to seek a national market. With the expansion of agricultural lands by further irrigation, with more intensive exploitation of the mineral resources, and with a greater utilization of the energy resources of the region—particularly hydroelectric power—the area will increase its industrial potential.

Lake Baikal. A small industrial zone has developed around the southern tip of Lake Baikal centering on Cheremkhovo, Irkutsk, and Ulan-Ude. These industrial centers have developed on the Trans-Siberian Railroad and serve the surrounding agricultural and mining region. The industry of the region is based on processing local resources and supplying the demands of the local population.

Mining activities are among the most important in the region. Industrial fuel is supplied by the Cheremkhovo and Tulun coal basins northwest of Irkutsk. Irkutsk has long been a supply point for the gold fields and, more recently, the iron ore, wolfram, and molybdenum districts. As a result of this function the production of machinery, particularly for the mining district, has developed in the area. Irkutsk has also developed as the petroleum refining center for eastern Siberia. A small motor vehicle industry has grown in recent years. To the west of Irkutsk the railroad towns of Angarsk, Cheremkhovo, Zima, Tulun, Nizhneudinsk, Kamyshet, Tayshet, and Kansk are centers having woodworking and small chemical industries. Tayshet is developing as an iron and steel center.

East of Lake Baikal, Ulan-Ude, the capital of the Buryat Republic, is the leading industrial center. It owes its importance to its nodal position on the Trans-Siberian Railway and the Selenga River. Ulan-Ude is situated at the place where the Selenga Valley meets the Uda Valley. Railroad repair yards were established early and the city has now become the largest locomotive and railway car producer in eastern Siberia. This factory is located in the center of the town and has an annual production capacity of 12,000 freight cars and 2,000 passenger coaches. The city has also developed industry based on local raw materials. Much of the area is forested and lumbering and woodworking have increased in importance in recent years. The timber converges on Ulan-Ude, where large sawmills are situated. The city is also the center of a fairly extensive agricultural region. One of the largest meat-packing factories in Siberia has been built here, producing tinned and frozen meat for export. Two large glass factories in Ulan-Ude supply the glassware to the whole of eastern Siberia. The largest textile factory in eastern Siberia is also located in Ulan-Ude, producing about a million yards of cloth annually.

Manufacturing is beginning to appear in the small towns of this area. A cement plant has developed at Temlyuy about 60 miles west of Ulan-Ude to supply the Transbaikalia area. Two leather and fur processing centers have developed in the region. One of these is at Chita, which possesses the largest fur and leather combine in the Far East. The other is at Chikoyski Savod, which gets most of its hide from the Mongolian People's Republic. Food processing plants are found in a number of the smaller places. Since 1943 sugar beets have been grown in the Buryat Republic to provide sugar locally. Sugar refineries have been built at Bechura and Chita.

Far East. A zone of manufacturing has developed in the Soviet Far East extending from Vladivostok northward along the Trans-Siberian Railroad to Khabarovsk and further north to Komsomolsk on the Amur River. The railroads and water routes are the major influences localizing manufacturing. Raw materials flow into these corridors for processing and finished goods are distributed to the region. Industry has long been retarded in this area because of its isolation, its small local population, which provides neither an adequate labor force nor a market, and its apparent lack of the necessary industrial raw materials.

The manufacturing centers are widely spaced along the transportation routes. Vladivostok, on the Sea of Japan at the southern end of the route, developed primarily as a commercial port city. Its industry reflects its geographic position. It is the major fishing port in the Far East and is noted for the canning of fish and crab products collected from the smaller fishing ports of the south coast. A well-developed woodworking industry, producing such items as furniture, plywood, and matches, is based on the extensive timber resources of the region. Vladivostok possesses extensive ship repair docks and a modest shipbuilding industry. It was once the leading center of this industry in the Far East, but has been surpassed by Komsomolsk. A petroleum refining industry has developed to supply a regional market. Other industries in Vladivostok include rice milling, tanning and leather working, an aircraft factory, and a small chemical industry producing such items as soap and oils.

Some 70 miles north of Vladivostok lies Voroshilov, in the heart of a rich agricultural area. This city processes such regional products as sugar beets, soybeans, and rice. One major soybean plant produces oil, glycerine, soap, oil cake, and other products. Continuing northward along the railway, Spassk Dal'niy has the largest cement factory in the Soviet Far East. This industry is based on local deposits of limestone and coal. In addition the town has flour mills and an oil refinery. In the Ussuri River valley timber is floated down the mountain streams from the Sikhote-Alin Range on the east to the Trans-Siberian Railroad, to be processed at Iman, Lesozavodsk, Bikin, Khor, and other centers.

Khabarovsk lies on the Amur River at the junction of the Trans-Siberian Railroad and the Ussuri River. It is a collecting point and transshipment center. A variety of industries has been established to serve the surrounding area. Of these, the mechanical industries have gained prominence. The Kaganovich works—producing motor vehicles—is the largest in the Far East. There are also aircraft as well as agricultural machinery factories. These engineering industries are supplied with iron and steel from Komsomolsk. Because this town is the center of shipping on the Amur it has a significant shipbuilding industry. A modern cracking plant has been added to the petroleum refinery in order to refine Sakhalin petroleum. Other important industries include cement, timber, apparel, and foodstuffs. The population of Khabarovsk has grown from 50,000 in 1926 to over 300,000 in 1960. The rapid growth is primarily a response to planned industrial expansion.

Komsomolsk, situated in the middle Amur Valley, shows the efforts of the Soviets to create industrial centers in wilderness areas. In 1932 it was a small fishing village of no importance. In that year under the Young Communist League's program, young people from Russia migrated to this area to develop its industrial potential. By 1939 a city of 70,000 inhabitants had been created and today the population is more than 150,000.

Komsomolsk was selected for industrial development because of the availability of iron ore and coking coal in the immediate locality at Khingan-Bureya, Olga Bay, and Suchan, providing the basis for a metallurgical industry. This city became the site of the Amur steel works, the only heavy metallurgical center in the Soviet Far East. As a response to the availability of iron and steel, other industries have developed. Because water routes are of vital importance in the area's transportation, shipbuilding has grown in importance. The first ships were launched in 1939, and the Komsomolsk shipyards are now the second largest of all industrial establishments built by the Soviets in the Far East, surpassed only by the Amur steel works. Engineering industries are developing but they remain small

because of the limited regional market. A number of industries have been created as a response to the growth of the city. For example, the industrial and residential construction has required the erection of a large brickyard in the town.

Industry is developing in a number of other cities of the area. Birobidzhan, the capital of the Jewish Autonomous Oblast, has the largest apparel factory in the Far East. The growth of heavy industry is planned, based on the Bira coal deposits and Kinkan iron ore. Nikolayevsk, at the mouth of the Amur River, is a fish processing center. New dock yards have been built at Sovetskaya Gavan and Petropavlovsk on the Kamchatka Peninsula, at Aleksandrovsk on Sakhalin Island, at Kokuy in the Amur region, near Sretensk on the Shilka River, and at Blagoveshchensk, at the mouth of the Zeya.

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CHAPTER FIVE
FAR EAST

In most Asian countries the development of modern, large-scale industry is of recent origin. The most advanced stages of manufacturing exist in Japan, mainland China, and India, where capital goods industries have developed. Although capital goods growth has recently been more rapid than that of consumer goods industries, production of consumer goods continues to predominate in these regions. The principal industrial growth since 1945 has been concentrated in China (mainland and Taiwan), Hong Kong, India, Pakistan, South Korea, and the Philippines. Japan's postwar industrial rate of growth has been possibly even more spectacular than that of other Asian countries.

In the countries which have recently developed manufacturing, a number of factors have been effective in encouraging growth. In the Philippines the significant increase in consumer goods has been aided by tariff restrictions and by a favorable investment climate created by relaxed credit arrangements and the liberal allocations of foreign exchange at special rates for the import of machinery and raw materials. The rise of manufacturing in Hong Kong is partly explained by the migration of capital, labor, and entrepreneurship from mainland China. Other factors include the temporary decline of the *entrepot* trade, governmental aid to newly established industries, the scarcity of land for agricultural development on the island, and the British imperial preference system, which favored the growth of export industries. In South Korea industrial rehabilitation and subsequent expansion were made possible by foreign aid, primarily from the United States and the United Nations Korea Reconstruction Agency.

A number of Far Eastern areas are still in an early stage of industrialization. Insurgent activity in Burma, Cambodia and South Vietnam has retarded growth of manufacturing. In Indonesia, British Borneo, Federation of Malaya, Singapore, and Iran, industry is basically confined to mining and petroleum production and processing. Modern industry is largely in the planning stage in Ceylon and

economic development in Thailand remains in a most primitive state. Economic data are lacking for North Korea, North Vietnam, Afghanistan, and Nepal.

FACTORS OF INDUSTRIALIZATION

It is the hope of most Asian countries to raise living standards with the aid of industrialization. The success of these endeavors will depend on the effective mobilization of human resources, the utilization of power and raw materials, the accumulation of capital at home, and the inflow of additional resources from abroad. The first question to be investigated is, "What factors are influencing the growth of manufacturing in Asia?" (10 and 11).

Importance of political changes. A major factor in the movement to raise standards of living by means of industrialization has been the achievement of political sovereignty in many areas with the subsequent appearance of obligations which this political independence entails. Before World War II, Afghanistan, Iran, Japan, Nepal, Thailand, and China were the only independent nations in the Far East. The Philippines became independent in 1946, India and Pakistan in 1947, Burma, Ceylon, and Korea in 1948, Indonesia in 1950, Cambodia, Laos, and Vietnam in 1954, and the Federation of Malaya in 1957. The most conspicuous repercussion of this independence on the economic structure of the nations involved has been the emergence of development planning. In nine of the eleven newly independent nations—as in most of the other countries—four- or five-year plans have been developed. In a number of countries, such as India and China, the economic plans have advanced beyond the first stage.

The plans have a wide scope and vary greatly in content. A number consist mainly of projected expenditures for rehabilitating and developing transportation and communications. Others are more comprehensive, and seek to evolve an integrated economy by means of a systematic development of all economic sectors. The emphasis varies depending upon stated goals. In such countries as China (both mainland and Taiwan) and India, importance is attached to the rate of growth of manufacturing, and industrial development is strongly emphasized. The long-range Economic Plan of Japan, which is basically a projection of that country's economy rather than a program of established goals, also points to a substantial growth within the immediate future. In a number of countries such as Afghanistan, Burma, Federation of Malaya, Nepal, and South Vietnam the economic plans concentrate on the development of the nation's resources. This is a necessary step if the basic raw materials are to be supplied at a later stage of industrialization.

There is little doubt that present planning looks toward industrial development as a principal means for bringing about a desired economic growth. The difference in the plans does not reflect intentional variations in procedure nearly as much as they do differences in resources and historical development of the country concerned.

Natural resources. The Far East has a wide variety of industrial resources. This area contributes a large share of the world's agricultural, fishing, and forestry products. For example, the region produces about 92 per cent of the world's rice, 95 per cent of its tea, 98 per cent of its jute, over 90 per cent of its silk, and about 83 per cent of its copra. The first industries to arise in these countries have been those that process agricultural products. These include sugar refining, flour milling, and textile manufacturing.

This region is also well-endowed with a variety of mineral resources. As for power sources, coal, lignite, petroleum, and natural gas deposits are widely distributed. China possesses one of the largest coal reserves in the world. There is also a vast hydroelectric power potential. At present the energy sources are little developed, with the area having only about 7 per cent of the commercial energy production in the world. In regard to metallic minerals, iron, tungsten, antimony and tin are fairly well developed. From the industrial point of view, iron ore is the most important metallic mineral found in Asia.

Human resources and technical training. If Asia's natural resources are unevenly distributed and, in certain areas, limited, its human resources are great. The present population is not only large but the rate of growth is extremely high. In some countries there are

already three dependents for every four persons of working age, and in the Philippines and China-Taiwan, the ratio is about 1:1, whereas in the industrialized countries of Western Europe it is only 2:3. One of the major problems of the area is the huge number of people supported by agriculture. It is the hope of most countries that industrialization will siphon off a large proportion of the excess rural population.

If there is a huge reserve of labor, however, it is almost always unskilled. The supply of technical skills required for industrial development has been and still remains inadequate in all Asian countries except Japan. The high rate of illiteracy has made all types of vocational training programs difficult, if not impossible, to implement. In India until 1950, only 40 per cent of the children in the age groups 6-11, and 10 per cent in the age group 11-17, attended some school. Facilities for technical and vocational education were altogether inadequate, and were largely confined to apprenticeship. This situation was even more serious in most other countries. In contrast, the Japanese government as early as 1903 had organized some 240 technical schools of higher and lower grades, in addition to technical colleges and universities, and over 1,000 elementary "continuation schools" for part-time instruction in the simpler skills required by industry, commerce, fishing, and agriculture.

Since 1950 an increasing emphasis has been placed on the development of vocational education. The advancements have been particularly striking in China-Taiwan and South Korea, and important advancements have been made in the Philippines, Thailand, and Hong Kong. Advancement appears not to be so great elsewhere but efforts are being made to improve training conditions. In mainland China during its first five-year plan, 1953-57, the enrollment of students in technical schools was scheduled to increase 516 per cent to about 672,000. In India the first official vocational training program began during World War II to supply technicians for both military and civilian purposes. This program has been expanded in recent years. However, in many countries progress has barely begun. In 1954, the total number of students enrolled in technical schools was reported as only 112 in Nepal, 91 in Cambodia and 60 in Laos.

There have been numerous problems in the development of a technical education program. These include the shortage of qualified instructors, the failure of the existing salary scales to attract suitably qualified men, the inability of governments to supply sufficient foreign exchange to adequately equip the training institutions, lack of coordination between governmental agencies in some cases, and lastly, the failure of training agencies to coordinate the type of training courses with the actual needs of industry. Foreign aid has helped establish programs in a number of instances. These include the United Nations (under its expanded Technical Assistance Program), the donor members of the Consultative Committee for the Co-operative Development of South and Southeast Asia (Colombo Plan), the bilateral aid programs of the United States, the Soviet Union and other countries, and international private organizations.

Governmental aid to private enterprise. The governmental role in the development of industrialization has increased greatly. To initiate and accelerate programs, the governments of the regions have both aided private enterprise and assumed the entrepreneurial role. The most important forms of government aid to private enterprise include the provision of public credit, tax concessions and subsidies, aids to domestic marketing and transport, protection and encouragement through tariffs, trade, and exchange control, and export promotion. Prior to World War II the availability of long-term capital was quite limited in all countries of the Far East except Japan. In recent years many governments have created financial corporations which channel public and private funds toward industrial development.

The governmental aid programs vary with the economic development of the nation. In Japan, long-term industrial credit had been supplied by government institutions until commercial banks were able to satisfy the demand. By the mid-1930's the commercial banks supplied over 90 per cent of long-term credit extended to industry and the government only about 1 per cent. In the early postwar years, the government again became a major source

of long-term credit, and by 1949 government credit was about 40 per cent of the total. Since this date the influence of the government in extending credit has declined.

The government of India established the Industrial Finance Corporation in 1948. Its capital of 100 million rupees was subscribed mainly by the central government and the Reserve Bank of India. The Corporation was designed to provide medium and long-term credit finance for public companies and for cooperative societies engaged in manufacturing, mining, and power generation. Similar types of credit organizations have been developed in most countries.

The Asian governments have often granted subsidies for the establishment of new industries. India, in 1948 granted a five-year tax exemption for new industrial establishments which employed at least 20 people, or were operated by the aid of power and employed ten or more persons. The government of Japan granted large subsidies to various key industries in the early postwar period of rehabilitation. In Pakistan, industrial undertakings established between 1947 and 1955 which used electricity and employed more than 50 persons were exempted from normal income tax and supertax on profits for the first five assessment years. In the Philippines in 1946, a four-year exemption from all internal revenue taxes was granted to companies engaging in a new and necessary industry; in 1953 the exemption period was extended to ten years.

In Asia very little aid has been given by the governments to assist private enterprise in marketing industrial products. The only exception lies in small-scale and cottage industries. Of the assistance that could be given, transportation and communication need the greatest development. With the exception of India and Japan modern transportation is poorly developed. In the economically advanced nations, the history of railway development coincides with the growth of domestic markets.

The importance of railways as a means of transport is demonstrated by mainland China. The railways account for over 80 per cent of passenger traffic and about 90 per cent of freight movement. Under the first five-year program in mainland China the railway mileage rose about 20 per cent. In other countries, progress has been slower. For the Far East as a whole, between 1950 and 1960 the the railway mileage increased by only about 6 or 7 per cent.

The Asian governments have aided industrial growth by such measures as protective tariffs, reduction of or exemption from import duties on industrial requisites, import licensing, foreign exchange allocation and bilateral agreements. It has been common practice for underdeveloped nations to use protective tariffs to encourage industrialization. After World War II, the Indian government gave tariff protection to 60 industries. Many of these had developed under war conditions and needed this aid to survive. Import and exchange controls, adopted primarily to conserve foreign exchange, have also stimulated newly developed industries. Export promotion councils have been organized under government leadership for such export industries as cotton textiles, chemicals, plastics, leather, rayon, sport goods, and engineering.

In the Republic of China, higher tariff rates have been instituted to protect some newly developed industries, especially cotton textiles and chemicals. The government of Japan, in an attempt to regain overseas trade lost during World War II, established the Japan External Trade Recovery Organization to supply information on foreign trade, operate trade centers abroad, and participate in international trade fairs. In 1956 the Philippines revised its tariff system to protect domestic industries. The government also uses import licensing and exchange allocations to give priorities to industrial raw materials.

Thailand lists 52 commodities that could be produced domestically under import licensing control. The government also adopted a link system which requires importers of certain commodities, such as gunny bags and grey cotton sheeting, to buy a certain percentage of these commodities from Thailand manufacturers.

Government entrepreneurial initiative. Prior to World War II, direct government participation in state enterprises was largely confined to postal, telephone and telegraph services, water supply, railway transport and

electricity. Manufacturing enterprises owned by the state were found in Japan in fairly large numbers. A few industries in China and Afghanistan were also owned by the government.

Since 1945 the growth of direct state participation in industrial growth has been a characteristic feature of postwar developments. There have been a number of reasons for this trend. The most important in some countries has been the acceptance of some form of socialism. In mainland China the goal has been to give the socialized sector, state, cooperative, and joint state-private owned establishments complete control of industry. In India, the emphasis has also been on the realization of the "socialist pattern of industry." This does not eliminate private enterprise but does increase the importance of government control. The Burmese government has created industry by establishing textile, jute, pharmaceutical, and brick factories. Ceylon, like India, has placed basic industries under state control. The government of Indonesia has also set up a number of industrial establishments.

In certain countries the development of state enterprises resulted from a lack of private capital and enterprise. If the government had not taken action the national economy would have stagnated. In the Philippines the government first planned to safeguard existing industry; but it was soon realized that in order to insure national welfare a more active part had to be played by the government. The Thailand government began operating several industries during World War II, and has continued to maintain control.

The government of Japan frequently established new factories during the early stages of industrialization. These plants in due time were sold to private investors. This method of industrialization has been followed in a number of countries. In Pakistan, textile, jute, and chemical plants have been transferred to private enterprise or are operated jointly. In the Philippines several cement plants have been sold by the government. At the end of World War II the government of Korea acquired all Japanese property. This included more than 90 per cent of the large-scale manufacturing industries. The original plan was to gradually transfer all of the property to private enterprise, but most of the industry remains under government control. In China-Taiwan the same situation existed, but here a considerable proportion of the industry has been sold to private enterprise.

Direct governmental influence in industry is also experienced in the establishment of technical research centers. These research institutes normally specialize in industrial engineering and are connected with national development programs. In India, industrial research is chiefly carried out under the auspices of the Council of Scientific and Industrial Research. The Council directs the work of the 13 national laboratories established since 1950. The government of Japan has engaged in organizing extensive industrial research ever since the Meiji restoration. In mainland China the Planning Commission for Scientific Development, under the State Council, has been in charge of national development plans for scientific and technical research. The Chinese Academy of Science has reported an increase in research institutions from 31 to 68, with an expansion in staff from 1,290 to 5,500.

Foreign aid. In order to establish industry in Asian countries most of the capital equipment and much of the raw materials have to be imported. These imports have grown more rapidly than total imports. In the majority of countries export earnings have not increased to a sufficient degree to pay for the increased imports.

The importance of the part played by foreign aid in the growth of manufacturing has varied from country to country. In China-Taiwan and South Korea, nearly all foreign exchange requirements for development of manufacturing were financed by the United States. Very substantial development aid was also given to Cambodia, Laos, and South Vietnam. In other countries external aid has been smaller, although still significant in the cases of Pakistan and India. For the period July 1945 to June 1958, United States aid reached $7,180,000,000, of which 87 per cent was accounted for by grants and 13 per cent by loans. The Soviet Union extended considerable aid to mainland China and lesser amounts to Afghanistan, Burma, Ceylon, India, and Indonesia.

GROWTH AND STRUCTURE OF INDUSTRY

The development of manufacturing in the Asian countries depends on many factors. In nearly all areas the highest priority has been given to the establishment of basic economic facilities such as power and transportation. A number of countries, such as the Philippines, Pakistan, China-Taiwan, Hong Kong, and Thailand, have attempted to diversify their economies by concentrating on the production of consumer goods. In contrast, mainland China and India have emphasized the growth of heavy industry in order to provide a strong industrial base for future development (11).

Types of industries. In the Far East as a whole, the heavy and chemical industries have tended to expand much more rapidly than light consumer goods industries. Between 1952 and 1960 the output of basic metals and chemicals, petroleum and coal products more than trebled. During the same period output of foods, textiles, tobacco and beverages only doubled.

In general, the output of producer goods has been handicapped by lack of technical knowledge, shortages of capital and management, and the difficulty of obtaining satisfactory labor. As a result, most of Asia is still heavily dependent on outside sources for the supply of capital goods necessary for further industrial development. For some types of producer goods, however, the standardized nature of production and demand, the availability of raw materials, and the high cost of transport have encouraged local manufacture. Cement is an excellent example. Most countries now produce cement, and many are self-sufficient.

Of the light consumer industries, the most common are labor-intensive industries with modest capital requirements, standardized machinery, plentiful raw materials, and a ready domestic market. In certain instances the lack of raw materials has not prevented the growth of these industries when a sufficient local or export market exists. This is illustrated by the rise of the cotton textile industry in Japan, China-Taiwan, and Hong Kong.

According to the national censuses of manufacturing in China-Taiwan, India, Pakistan, and the Philippines, consumer goods industries contribute two-thirds of the value added by manufacturing. In India and Pakistan, textile manufactures contribute almost one-half, and in China-Taiwan and the Philippines, food processing contributes about two-fifths of the total value added by manufacturing. In contrast, total consumer goods in Japan contribute about 45 per cent of the total value added by manufacturing, and producer goods about 55 per cent.

In a number of countries industries have been established to process local products for export. Examples of these industries include jute processing in Pakistan and rubber milling and tire manufacture in Indonesia. Some industries are also based on the assembly of imported components, or process imported raw materials in order to effect a net saving in transport costs. These industries include motor vehicle assembly in India, oil refining in mainland China, and electrical apparatus assembly in the Philippines.

Rates of growth and per capita production. The volume of industrial production has risen steadily in the Far East. The increase in the region has been significantly higher than the average increase for the world as a whole. Between 1950 and 1960 the world expansion amounted to about 60 per cent, while most countries in the Far East had an increase of 100 to 200 per cent. These impressive rates of growth, however, are largely due to a low starting base. The total contribution to the world's manufactured goods has remained small.

An important measure of the degree of a nation's industrialization is provided by the amount of industry found in the national output. Only in mainland China, China-Taiwan, Japan, and Hong Kong is the proportion of industry as high as about one-third. In all other countries the proportion of national output for industry is below 20 per cent. For industrially advanced nations in other areas, the corresponding share for industry is about 40 per cent.

The per capita level of industrial production varies considerably from country to country. Japan, with a long industrial tradition, has a generally high per capita output. For example, Japan is by far the leading iron and

steel producer, making about two-thirds of the steel and one-half of the region's pig iron, and its per capita production of 123 kilograms is 20 kilograms higher than the world average. In a number of countries, although per capita output has risen considerably in recent years, the level is still quite low.

Structure of factory industry. Factory industry in the Far East is a mixture of large-scale and small-scale establishments. Because of lack of adequate data it is not possible to analyze factory employment precisely or completely. Nevertheless, a broad understanding of factory industry is possible. In the Far East factory employment is classified generally into three general groups, food and textiles, metals and engineering, and miscellaneous fields. The food and textile industries have always been the first industries to arise when a country begins to industrialize. The availability of a domestic market, the relatively modest amount of capital required, and the little technological skill needed favor the early growth of these industries. As a nation matures industrially the metals and engineering industries increase in importance. For example, the United Kingdom as late as 1911 had 50.3 per cent of total manufacturing employment in food and textiles. By 1960, however, the proportion had declined to about 20 per cent.

The size of the factories in the Far East is determined to a large degree by the size of the local market. For example, in Pakistan and the Philippines most of the plants are small (fewer than 50 workers) but, again, goods which have a large domestic market such as tobacco, beverages, textiles, rubber products, and paper are produced in large factories. In India, in spite of government encouragement of small-scale industry, the average size of establishments is considerably larger than in most other countries. This is due partly to the size of the domestic market and partly to the existence of well-established financial institutions. Although large-scale establishments are common in the Japanese factory system, highly mechanized small-scale plants employ the greater percentage of workers.

Cottage and small-scale industry. In recent years, the Asian governments have frequently given special attention to cottage and small-scale industry. This type of industry is particularly suited to underdeveloped countries with limited capital but with abundant manpower. Because of the small size of these industries and the resulting problems of collecting data, it is difficult to give a precise evaluation of present trends. Within this category are the primitive cottage industries situated in rural areas, producing goods to satisfy local needs. It also includes the urban, modernized, small-scale industry, which is usually engaged in the manufacture of consumer goods, either independently, or in processes complementary to large-scale manufacture, often for national or world markets (10).

The importance of these industries appears to be significant in nearly all Far Eastern countries. In statistics provided by mainland China, the size of establishments is not given in terms of employment. The nearest equivalent to cottage and small-scale industry is the sector comprising handicraft workshops, cooperatives, and individual craftsmen. It appears that during the 1950's in mainland China the handicraft, or small-scale, industry contributed about one-third of the gross industrial output. This share is gradually declining with the expansion of large-scale state-controlled industry. In the planned economy it is maintained that a careful distribution of investment among large, medium, and small-scale plants can bring about a larger output within a shorter period of time than can a concentration on large-scale plants.

India's national income statistics define the small-scale industrial sector as comprising enterprises with fewer than 20 workers. It appears that until recently, cottage and small-scale establishments in India accounted for more than half of the total industrial product. However, their share has continually declined since World War II. An important method of developing Indian cottage and small-scale industry is the construction of industrial estates, usually in small towns. These estates provide factory space and common facilities. Under the second five-year plan, 62 industrial estates were built in rural areas.

In Pakistan in the 1950's, cottage and small-scale establishments with fewer than 20 employees contributed about 75 per cent of the total national product originating in the industrial sector. This reflects the underdevel-

oped state of Pakistan's industrial economy. In contrast, in Japan, according to the 1954 census of manufactures, the net value added of the output of enterprises with 4 to 19 employees amounted to only 14 per cent of the total net value added of output of the industrial sector as a whole. Small enterprises in Japan are, on the whole, efficient and technically advanced. Their management gets help in solving their technical problems from an expert consulting service.

JAPAN

The Japanese nation has a long industrial history. The traditional handicraft industries reached a high degree of perfection prior to 1850. In such industries as textiles and chinaware the Japanese products were equal to and in certain aspects better than the finest wares produced in Europe prior to the Industrial Revolution. The well-established handicraft industries were the foundation for the evolution of modern industrial Japan after 1870.

Evolution of industrial Japan. In the change from handicraft-oriented industries to a modern industrial nation, emphasis was first placed on the output of traditional products. These include silk fibers, chinaware, apparel, toys, and objects of art. The early manufacturing processes were simple. Most of the output was carried on in organized workshops, where simple motor-driven machinery was used in conjunction with hand tools. The establishments were small, usually having under 30 workers. Little capital was needed to establish these early factories. Many of the items produced were exported. In turn, foreign manufactured goods were imported for which a large market rapidly developed in Japan (14).

As the market for foreign manufactured goods expanded the second phase of the Japanese industrial evolution began, starting with the mass production of these commodities domestically. This was made possible by the importation of machinery and the borrowing of technical knowledge. Of the industries that developed, textiles held a dominant position. The production of traditional chinaware in mechanized factories was also strongly developed. The factories, moderate to large in size, were normally individually owned. Because of the large investment in machinery, a centralized system developed, and considerable emphasis was placed on vertical integration. As industry became more important in the domestic economy, a system of protective tariffs was created after 1910. The sound industrial foundation established prior to World War I made it possible for Japan to increase production rapidly when imports from Europe were temporarily halted. As mass-produced items became increasingly available, the Japanese began to realize that domestically manufactured goods could be produced more cheaply than imported products. This led to the philosophy of "not-so-good-but-twice-as-cheap" that dominated Japanese mass production industries. Because raw materials were imported to support the Japanese industries, the demand for foreign credit increased greatly. This led to the expansion of international trade. The low-cost Japanese goods found a ready market in the low-income Asiatic countries. There also developed a considerable export of silk to the United States. There is evidence that in the 1920's the domestic market was neglected in order to develop foreign trade (18).

The next stage in Japanese industrialization came with the emphasis on the growth of heavy industries and the development of a domestic machinery industry. This shift in emphasis was fostered by a number of considerations. After 1930 the Japanese government was increasingly committed to a program of military conquest for which a high degree of industrial self-sufficiency was a basic requirement. After the conquest of Manchuria in 1931 the heavy industrial products of the area, particularly iron and steel, became available to Japan not only for modernizing existing plants, but in expanding domestic facilities.

The output of iron and steel in Japan proper was also increased. In 1931 Japan was the fifteenth largest steel producing nation. By 1936 it had risen to sixth place, behind the United States, Germany, Russia, United Kingdom, and France. In the period from 1929 to the outbreak of the Sino-Japanese War in 1937, Japanese industry experienced an exceptionally rapid growth. Japan more than doubled her electricity-generating capacity in

the 1930's. During this period the index of industrial production shows a decline from 100 in 1929 to 92 in 1931, but this was followed by an uninterrupted rise to 171 in 1937. The significant growth occurred at a time when the United States failed to regain its 1929 level of output.

During the 1930's all industry expanded but it was the capital goods industries which experienced the greatest increase. As a result of this growth pattern the composition of industry was changed considerably. In 1929 textiles accounted for over 50 per cent of employment in manufacturing, and metals, engineering, and chemicals combined for only about 25 per cent. By 1937 the percentage of workers in textiles declined to about 35 per cent of the total and those in metals, engineering, and chemicals rose to 42 per cent. In the period 1930-1937 the index for consumer goods increased from 100 to 154, but for capital goods the increase was from 100 to 264 (13).

A wide variety of industrial commodities began to be produced in Japan. Until the end of the 1920's Japan depended to a large degree on imports of machinery to equip her factories. By 1937 Japan's domestic production was sufficient enough in most items to allow the construction of factories. The machinery industry was rapidly expanded and included the output of textile machinery, scientific instruments, and electrical equipment. Japan had achieved so advanced an industrial system that machine tools, the final stage in achieving industrial self-sufficiency, were being produced.

The development of the capital goods industries was achieved without an absolute decline in the consumer industries. The cotton and woolen textile industries experienced notable increases. The increase in cotton was primarily due to the rising export market and the woolen and worsted industries grew from the domestic demand for Western-style clothes. In 1929 the rayon industry was in its initial stage of development. By 1937 Japan was the world leader in output of rayon filaments.

A number of other industries, such as pottery, toys, shoes, hosiery, hardware, and apparel, also expanded. The number of workers in mining and manufacturing rose from about 6 million in 1930 to 8 million in 1937. By the latter date manufacturing was contributing twice the amount to the national income as agriculture. The industrial output of Japan in 1937 was probably twice that of the whole of Asia, excluding the Soviet Union. Japan had thus become a highly industrialized nation.

Industrial trends during World War II. Manufacturing expanded greatly in the period from 1937 at the outbreak of the Sino-Japanese War until early in 1945. After 1941 the composition of the industry changed. The heavy industry and engineering firms were enlarged. In contrast firms producing consumer goods and those based on an export market were largely converted to the output of war commodities. In 1944 the output of engineering goods reached its peak at a level three times that of 1937. An immense growth had occurred in the production of machine tools and aircraft. This increase was accomplished not only by expansion of the large firms, but also by enlarging the small producers. Subcontracting became an established practice with the large firms. As the war continued expansion became more difficult. Once the shipping lanes were blockaded by the Allied navies imported raw materials were no longer secured in sufficient quantities to maintain a high level of production. In the later stages of the war the bombing of Japanese cities greatly reduced the industrial capacity of the nation. At the end of World War II, Japan's economy was in ruins.

Modern trends. Japanese industry did not recover rapidly at the conclusion of World War II. In 1946 it was estimated that industrial production was only 30 per cent of the 1934-36 period and in 1947 rose to only 37 per cent. The slow industrial recovery was due to a number of factors. The defeat and occupation of Japan depressed the spirit of enterprise. The Japanese had to reevaluate their economic position in a world that had changed since the 1930's. More important it was the declared policy of the occupying powers to destroy the material base of Japan's imperialism and at the same time to foster institutions believed to be favorable to the development of a democratic society. In order to destroy the war potential of the nation, restrictive policies were applied to the redevelopment of indus-

try, particularly those pertaining to metals, chemicals, and engineering products. There were also restrictive reforms calculated to decentralize the wealth and industrial initiative of the nation. The measures included the introduction of labor laws, the dissolution of the largest firms, the removal of business leaders from responsible positions, and the development of many social welfare programs. Besides these restrictive measures, the Allies in the early war years were interested in the development of a reparation program. Although the early reforms may have had desirable political and social implications, the economic recovery of the nation was stifled (13).

By 1948 it became evident that the early economic controls imposed by directives from the Supreme Commander of the Allied Powers were not successful. In 1947 more than $400,000,000 in American aid was needed to maintain the Japanese economy. The depressed financial conditions were harmful to the growth of a democratic state. The evolving political conditions in the Far East also necessitated a change in policy. The rise of a communist state in China and the deterioration of relations between the United States and the Soviet Union made the economic recovery of Japan necessary.

Beginning in 1948 Japanese economic recovery became the goal of American relations with Japan. Reparations were stopped. International trade was once again encouraged and huge sums were provided for the import of food and raw materials. Labor reform measures were modified. The currency of the nation was stabilized. Reconstruction of industrial facilities progressed rapidly. By 1950, although industrial output was still below prewar levels, manufacturing had adjusted to the new economic situation.

The outbreak of the Korean War in 1950 had a profound effect on the redevelopment of Japanese industry. The demands of the United Nations forces created an immediate market for manufactured goods in Japan. By 1951 the index of industrial production exceeded the annual prewar average for the first time since 1944. The Korean War not only stimulated expanded manufacturing, but provided a reason for a revision of occupation policies. In 1952 the Peace Treaty and Security Pact came into effect, giving full sovereignty to Japan. Although there was no mention of economic policies, it was recognized that Japan had freedom to develop her own economic objectives (13).

Japan's industrial output increased each year in the 1950's, except during the mild world economic recession of 1958. The depression was short-lived, for in 1959 manufactural output was 24 per cent above the 1958 level. Various factors have contributed to this trend. After the Korean War it was greatly aided by the continuing large-scale procurement purchases of the United States Security Forces in Japan. Between 1952 and 1956 their payments totaled $3,380,000,000. In most years they were nearly equivalent to the value of exports. The Japanese have been experiencing one of the fastest rates of economic growth in the world, averaging at least 7.5 per cent annually between 1957 and 1960. As a result the domestic market has been greatly expanded, reflecting the rise in real wages. There has been an extraordinarily high rate of capital investment, combined with effective utilization of management and labor skills. During the 1950's there continued the adoption of a wide variety of modern industrial techniques from abroad through licensing arrangements. Economic growth has been aided greatly by the ability of the government to maintain generally sound fiscal and monetary policies.

Japan's export market for manufactured goods has risen steadily. The increase in exports of manufactured goods is due to a number of considerations. With the general improvement in world economic conditions there has been a corresponding rise in world trade. In order to benefit from this trend, Japan has carried out a successful trade promotion campaign and at the same time has made her manufactured commodities more competitive by reducing the "cheap goods" exported. Major factors in Japan's improved competitive position in the world market were lower prices for many raw materials, a marked decline in ocean freight rates, increased productivity through application of mass production methods, and the continued introduction of modern industrial techniques.

Structure of the industry. The structural changes of Japanese industry inaugurated in

the 1930's have continued in the postwar period. Emphasis has been placed on the production of heavy machinery, electrical equipment and chemicals while the traditional industries, such as textiles and nondurable consumer goods, have lagged in their expansion. Although the textile industry has by far the largest number of firms and employees, it is exceeded by machinery and the chemical industries in contributing to the gross national product. In recent years textiles have contributed about 13 per cent, while machinery contributes 21 per cent, of the gross national product.

Japan's industry is, and will likely continue to be, primarily comprised of small and medium-sized firms. However, firms with 30 or more workers are increasing, and some of Japan's largest establishments compare favorably in size, equipment, and output with larger firms in other countries. The number of workers in manufacturing has increased steadily. The manufactural labor force totals 8,900,000 or nearly 25 per cent of the total labor force. In the period 1953-59 the employment index of regular workers in establishments hiring 30 or more employees rose from 100 to 136.3. There were considerable variations in 1959 from that average for the key industry sectors with textiles at 107.7, chemicals and related products at 114, iron and steel at 127.7, electrical machinery at 177.3, medical and scientific instruments at 171, nonferrous metals at 152, and miscellaneous manufacturing at 193.5.

Industries. Japan has frequently been called the workshop of Asia because of its large and diverse industrial complex. The future prosperity of Japan will depend to a large degree on the ability of its factories to absorb a greater percentage of its growing labor force. Japan has not only the largest industrial plant in the Far East, but is one of the world's leading industrial nations.

As in other countries of the world, the Japanese iron and steel industry is recognized as a basic industry. Japan's output of iron and steel has increased rapidly and now totals about 20 million tons of crude steel and 11 million tons of pig iron. In 1959 Japan replaced France as the world's fifth ranking steel producer. The increased output of steel in Japan has been made possible by expanded and modernized facilities and the introduction of new and improved techniques for steel making. Much of this development has been accomplished through foreign loans, chiefly from the United States, and technical assistance agreements with the United States and other countries. Emphasis has been directed toward modernizing rolling and strip-and-plating mills, reducing production costs by more efficient methods of treating ores, and by introducing oil in place of coal as a fuel.

Japan possesses the most advanced and largest machinery industry of any country in the Far East. Although the development of new techniques lagged during World War II, Japan has attempted to bring the level of the machinery industry up to those approximating Western standards. Japan has imported a number of techniques, primarily from the United States. In certain operations Japan considers domestically developed techniques on a par with those of the West.

Japan now produces a wide diversity of machine products ranging from machine tools to mammoth ships. The machine tool industry has made rapid progress in recent years. Improvements have been attained through various technological agreements with foreign countries and through domestic research. However, the industry continues to lag behind that in advanced nations, particularly in the production of large and complicated tools. Basic problems involve high cost of production and lack of technical know-how in producing machine tools to close tolerances. Export of machine tools has been negligible, while, in contrast, Japan's import of machine tools has been substantial.

The electrical machinery industry has experienced a more rapid growth than any other Japanese industry. Output of electronic goods rose from $270,000,000 in 1957 to over $1,000,000,000 in 1960. Radios and television sets are the principal products. Output of radios rose from 1,800,000 sets in 1955 to over 10 million in 1960. Transistor radios account for over 80 per cent of the total. In 1960 about 3 million TV sets were produced, more than a twenty-fold increase in five years. Production of more complicated and advanced electronic devices, such as computers, measuring and control in-

struments, and communicating equipment is rising rapidly. Progress in the field of semiconductors, transistors and diodes has been notable. Output of transistors rose from 9,600,000 in 1957 to over 86 million in 1959. Japan ranks, at or near the top, as a producer and exporter of these products. Although foreign technical assistance has been utilized in this field, Japanese engineers and scientists have made highly important contributions.

Japan became the world's largest shipbuilder in 1956, as well as the world's largest exporter. Production has fluctuated between 1,700,000 and 2,450,000 gross tons annually in recent years. Export construction is dominated by large tankers and bulk cargo carriers. The technical level of Japanese shipbuilding is high. Facilities in the 34 major yards have been expanded and modernized. The construction period has been reduced through the use of prefabrication, assembly line techniques. Marine machinery, much of which is produced under foreign license, has been considerably improved.

The motor vehicle industry has also experienced rapid expansion. For example, the output of passenger cars in 1959 increased by 55 per cent over 1958 to 78,000 units and trucks by 36 per cent to 177,000. Until 1957 production was primarily for the domestic market. Since then foreign markets have been sought with the construction of assembly plants in Taiwan and Brazil. A problem of the industry has been to produce an automobile which is not only cheap but also durable. Through the introduction of mass production techniques prices are being lowered and quality improved.

The Japanese aircraft industry was well developed during World War II, and in 1944 some 24,000 planes were produced. At the end of the war the industry was dismantled, but was revived on a limited scale in 1952. Aircraft producers now rely primarily on contracts for the repair and overhaul of United States military aircraft and the manufacture, under United States license, of limited numbers of jet fighters and trainers for the Japanese Self-Defense Forces. In order to lessen the industry's dependence on military orders, a short range turboprop commercial plane is being produced.

A number of specialty machines are produced. In this category, the sewing machine deserves mention. Japan's household sewing machine industry depends primarily on exports, with 80 to 90 per cent of the output entering international trade. About 2,000,000 units a year are exported, of which about one-half enters the United States. By a system of rigid testing and inspection, quality, as well as a low price, has been maintained.

The textile industry still ranks most important among Japan's manufacturing industries in terms of establishments and employees, value of output, and foreign exchange earnings. The structure of this industry has undergone significant change. Although cotton remains the dominant sector of the industry, the rise of the synthetic fibers has been noteworthy. The silk industry, which in pre-World War II years accounted for as much as 20 per cent of Japan's total exports, has experienced difficulties in competing with synthetic textiles. The rapid expansion in the production of synthetic fibers highlights recent development in the Japanese textile industry. In 1958 Japan was second only to the United States in the production of synthetic fibers. Output in 1959 more than doubled the 1958 total and the export trade increased significantly. Agreements between the United States and foreign firms on technical processes, particularly for the production of nylon and polyester fibers, have been responsible in a large measure for the increase in output. However, the Japanese techniques and processes, especially in the manufacture of vinylon, vinyl chloride, and polyacrylonitrile fibers, have also contributed to the growth pattern. Some Japanese techniques have been licensed abroad. In contrast to the synthetic fiber sector of the industry the cotton textiles have been subject to a number of complex problems. Largely due to a decline in the relative importance of the export market, to competition from the newer, more acceptable synthetic fibers, and to competition from foreign producers, the industry is plagued by excessive capacity and subject to periodic overproduction. Movements abroad to curb Japanese imports have forced the industry to voluntarily limit the export of cotton goods to the United States and to several European countries.

The Japanese industrial organization comprises a wide variety of secondary industries. In the aggregate these industries are important, since they provide employment for a large number of workers and contribute to the nation's foreign credit. One of the rapidly expanding secondary industries is that of electric household appliances. Most of the output has been sold on the domestic market but exports are increasing. It is estimated that about 70 per cent of all Japanese households possess electric irons, about one-quarter have electric rice cookers and washing machines, over 20 per cent have electric foot warmers and fans. However, only about 6 per cent have refrigerators or vacuum cleaners.

The optical and photographic goods industry is one of Japan's most important light industries. Cameras, binoculars, and microscopes are the principal products, but the output of photographic accessories has increased. The highly competitive industry is dominated by a half dozen firms. The technical level, particularly in the output of lenses, is high, and is considered by some experts to rival that of West Germany, the traditional leader. In order to insure quality control, the Japanese government now requires compulsory inspections to meet minimum export standards. Domestic demand has contributed to the success of the industry, but exports are increasing. Exports of optical goods, which were negligible in 1955, now account for nearly 40 per cent of Japan's camera output and about 90 per cent of its production of binoculars and microscopes.

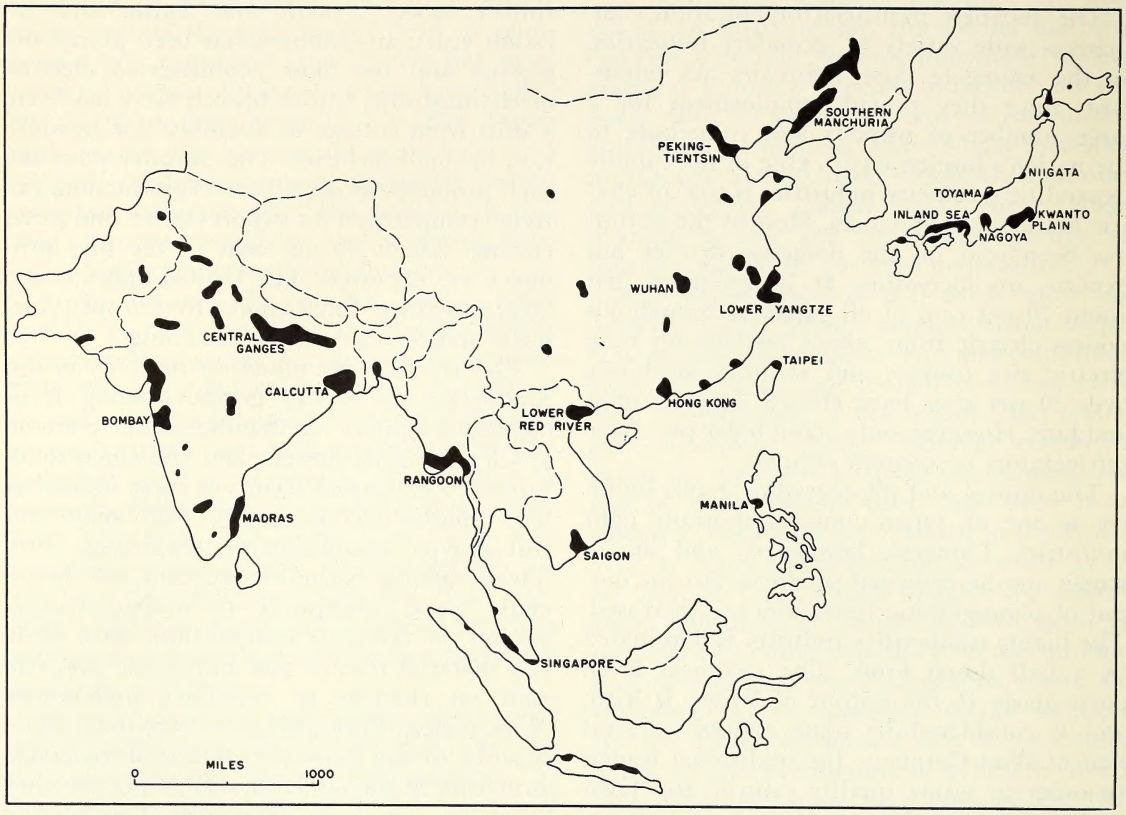
A number of traditional industries remain important in the modern industrial structure of Japan. The production and export of pottery and porcelain have risen steadily. Domestic consumption of kitchen pottery and porcelain has been stimulated by the high level of the domestic economy. The United States, which takes about one-half of the industry's exports, is the primary market for quality goods, while Southeast Asia receives the major proportion of the low-cost wares. The manufacture of toys is a traditional cottage-type industry characterized by small producers and subassemblers. Simple metal toys account for some 80 per cent of value of the toy production, followed by celluloid, rubber, wood, ceramic and textile toys. In recent years, an emphasis has been placed on plastics and the more sophisticated electromechanical toys. In this branch there has been a shift from cottage to assembly line production in small factories. The industry possesses such problems as periodic overproduction, extreme competition for export orders, and price cutting. About 90 per cent of the toys produced are exported. The United States is the largest market, but exports to Europe, Australia and South America are rising.

The Japanese are noted for diversity in the production of sundry goods, ranging from cigarette lighters to bambooware, costume jewelry, artificial flowers, and Christmas decorations. The various sectors of these industries have similar characteristics. The small and cottage-type establishment dominates. Producers, almost without exception, are financially weak, susceptible to overproduction, subject to excessive competition, have little raw material reserve, and have little information on changes in consumer preferences. Nevertheless, these industries contribute significantly to the Japanese industrial economy, primarily in the large number of persons they employ and the value of exports. The value of such exports is estimated at between $200 and $300 million annually, a large part of which goes to the United States.

Manufacturing Regions

As in most countries manufacturing in Japan is not evenly distributed. The major manufacturing districts are situated on the coast and those in the interior are relatively small. The largest industrial districts are the Kwanto Plain, with manufacturing centered in Tokyo and Yokohama; the Kinki Node, centering on Osaka and Kobe; the Nagoya Node; and the Kita Kyushu Node of northern Kyushu and southwestern Honshu. Outside of these concentrations, a number of smaller manufacturing centers are situated on the west coast, facing the Sea of Japan, and in Hokkaido (23).

Kwanto Plain. The Kwanto Plain, with manufacturing centering on the cities of Tokyo, Yokohama, and Kawasaki, is the largest single industrial area of Japan (23). Within



5.1. Manufacturing Regions of the Far East.

this node are approximately 25 smaller industrial cities. This area has few natural resources to attract manufacturing. Its most important physical resource is undoubtedly silk from the silkworms feeding on the mulberry trees of the region. Much of the coal consumed by the industries comes from the Joban fields, 100 miles to the northeast in Fukushima Ken, and some from north Kyushu and Hokkaido. Hydroelectric power is relatively abundant, coming from the mountains of central Honshu.

A number of factors have contributed to the industrial dominance of the Kwanto Plain. Tokyo is not only the political and cultural center of Japan, but also possesses leading banking and commercial facilities. Capital is more readily available for industrial investment here than in any other region of Japan. Tokyo and Yokohama are major overseas ports; foreign raw materials are readily assembled at these points, and export of manufactured goods is facilitated. This is also a rail hub, giving access to domestic markets and domestic raw materials. The population concentration of about 10 million people provides not only the largest single market in the nation, but also a skilled labor supply. Since World War II this area has usually possessed an oversupply of workers. The mountains to the west of the plains have a heavy rainfall, assuring the region of a plentiful, pure industrial water supply. Finally, the Kwanto Plain is the largest level area in Japan, providing a site for cities and factories.

The region is characterized by a great variety of manufacturing industries. Major products manufactured in Tokyo include foodstuffs, optical instruments, chemicals, machinery and other engineering industries, and printing. Factories are widely scattered throughout Tokyo, but the principal industrial zone is found on the Tokyo Bay waterfront. Another district follows the Sumida River in eastern Tokyo. Southeast of Tokyo a large integrated

iron and steel plant has been developed at Chiba, and lesser industrial establishments are found in the ring of cities that surrounds Tokyo.

The Yokohama-Kawasaki area is dominated by heavy industry. The assemblage of the raw material for these factories is dependent on water-borne commerce. The industry in these cities is thus concentrated on the waterfronts, where filled-land sites have been developed. Today a complex pattern of blast furnaces, steel mills, machine shops, chemicals, oil refining, shipbuilding, aircraft factories and textiles makes up the industrial landscape.

Kinki Node. The Kinki Node, centering on the cities of Osaka, Kobe and Kyoto and including Nara, Sakai, and Wakayama, is the second industrial concentration in Japan. As in the Tokyo-Yokohama area the coastal position plus the availability of level land have been considerations in the establishment of manufacturing. Osaka is one of the nation's major deep water ports. Besides water, rail facilities are also excellent. This area is not as well situated for securing hydroelectric power, since it is farther away from the principal hydroelectric centers than either Nagoya or Tokyo. It does, however, lie somewhat closer to the coal deposits of nothern Kyushu, and more thermal electricity is developed in this area.

Since the Kinki Node possesses similar localization characteristics to the Kwanto Plain, the manufacturing structure for the two areas has many similarities. The district is characterized by great diversity. It was originally noted for its textile industries, with spinning concentrated in Osaka and weaving in the outlying centers. Since the 1930's emphasis has been placed on the heavier industries, causing this region to become a primary metal producing center, with associated engineering industries. This node produces about one-third of Japan's iron and steel, and a little less than half of the rolling mill output. Shipbuilding, machinery, aircraft, and foundries are well-developed industries. Other leading industries include chemicals, oil refining and food processing.

This area presents a modern industrial landscape that has little beauty. Within Osaka, industry is widely dispersed, partly due to the many canals which crisscross the city and provide water transportation to every portion of the urbanized area. The central portion of Osaka has the general appearance of a Western city, but the outlying areas are typically Japanese, with many of the factories exhibiting a Japanese style of architecture. Within the area, Kyoto, the old capital, still retains much of the traditional charm of Japan. Until recently it was a principal center of handicraft industries and had escaped the grime and noise of the newer industrial cities.

Nagoya Node. The Nagoya Node occupies the Mino-Owari Plain at the head of Ise Bay. This area possesses both advantages and disadvantages for industrial growth. Nagoya, the major city, developed early as an administrative center, and its location on the Tokaido, or Eastern Sea Road—the main highway from Tokyo to Kyoto—facilitated its industrial growth. The district, located on one of the larger plains of Japan, possesses ample space for industrial facilities. Although coal is not found locally, it is imported relatively easily by water from the north Kyushu and Hokkaido fields. The area is well situated to tap the principal sources of hydroelectric power from central Honshu. This is a densely populated plain, providing an adequate labor supply. It is also situated on the main Tokaido railway line.

The growth of the Nagoya industrial node was long delayed for a number of reasons. Until the 1930's the port of Nagoya was inadequate as a major ocean shipping point. The lack of a deep sea port, plus the presence of a poorly developed canal system within the city retarded industrial growth. Much of the trade for this area passes through the Kinki or Kwanto ports and consequently entails a railroad haul. The industrial development of Nagoya has also been handicapped because of its nearness to the two larger centers of Tokyo and Osaka. Industry tends to be attracted to the larger agglomerations because of more favorable factors.

Since the assembly of raw materials was relatively difficult, Nagoya is noted for its light manufacturing and small-scale industry. Of the leading manufacturing regions in Japan Nagoya is the only one in which textiles are the most important. This industry includes

not only silk reeling, but also cotton spinning, and cotton and wool weaving. Of the metal industries, machines, machine tools and small fabricated products are of importance. Prior to World War II Nagoya became an aircraft center, and since the war a leading automobile center. Its pottery industry, based on local clays, is the largest in Japan. Chemicals and food processing have also thrived in the area.

Kita Kyushu Node. The Kita Kyushu Node, centering on the five northern Kyushu cities of Moji, Tobata, Yawata, Kokura, and Wakamatsu, and Shimonoseki (across the strait on Honshu), is a major center of heavy industry (24). The development of a large iron and steel industry in this region has been favored by the presence of the Chikuho coal fields, the largest in Japan. The early growth of the Yawata Iron and Steel Works, one of the largest industrial establishments in Japan, was strongly subsidized by the Japanese government. About one-third of Japan's pig iron and between 40 and 50 per cent of its steel is manufactured in north Kyushu. As a result of the local availability of iron and steel a significant engineering and metal fabricating industry has developed. Nevertheless this area produces an excess of steel, which is sent to other industrial districts of the nation. This region is characterized by large factories and massive operations.

Besides the heavy metal industries, a number of other industries have prospered. Extensive deposits of limestone, clays, and shale, plus local coal, have initiated the cement, glass, and pottery industries. Since this area lies at the western maritime entrance to Japan, it has ready access to the importation of raw materials and foodstuffs from southeastern Asia. Shimonoseki, Moji and Wakamatsu are port cities of some size. Much of the raw materials entering these ports is processed locally. As a result, chemicals, petroleum refining, sugar refining, rice and wheat milling, and distilling are other important industrial functions that are integrated into the industrial complex. It is interesting to note that this is the only major industrial area of Japan where textile industries are of slight importance.

This area is now experiencing some industrial problems. There is a shortage of industrial water. The lowland areas are almost completely occupied so that there is congestion, which hampers the efficiency of the present industrial operations and limits possible future expansion. The port facilities have also about reached their limit so that the prospect of expansion of those plants dependent on imported raw materials is fairly bleak.

Industrial nodes on the Sea of Japan. The cities on the west coast of Japan have not developed manufacturing as much as those on the east and south coasts. Nevertheless the Niigata and Toyama nodes are of some importance. The Niigata industrial zone includes several large centers that developed along the Shinano River, with the rail routes centering on Niigata. The traditional industry of the area is textiles, but the industrial base has been enlarged by the introduction of chemicals, primary metals, machinery, and fabricated metal products. The abundant supply of hydroelectricity and extensive deposits of limestone have encouraged the growth of the electrometallurgical and chemical industries. Shipbuilding, some crude oil production, and textiles have provided a market for related machinery manufacture. Specialities of the region include cutlery and tableware, produced at Sanjo and Tsubame.

The Toyama Node is one of the newer industrial centers. The industry is fairly widely dispersed in the area. The availability of low-cost hydroelectric power has attracted modern factories producing chemicals, electrometallurgical and electrochemical products, and paper and textile commodities. Local limestone deposits and cheap labor have been additional attracting influences. The traditional handicraft industries of copper and lacquerware and the dyeing of textiles remain but are of minor importance. Pharmaceutical production, present in the region since the seventeenth century, continues.

CHINA

The industrial progress of China under the communist regime has been significant. When the communist government came to power in 1949 the initial steps were to rehabilitate existing industry and to destroy the old eco-

nomic system. At this time the state became the "coordinator, regulator and leader" of the various segments of the economy as well as state enterprises (31).

By 1952 the initial steps toward imposing a communist-controlled system were completed. A manufactural economy was being implemented and previous peak levels of production were surpassed in nearly all aspects of manufacturing. The first five-year plan was inaugurated at the end of that year and the subsequent records of fulfilling planned targets are quite impressive. During the period 1952 to 1959 coal output rose from 63.5 million tons to 347.8 million tons, steel increased from 0.92 million tons to 13.35 million tons, chemical fertilizer rose from 181,000 to 1,333,000 tons, metal cutting machine production rose from 13,700 to 70,000 units, and cement output increased from 2.29 million tons to 12.27 million tons.

During the first five-year plan the major effort in industrialization was concentrated in the northern part of the country for several reasons. Emphasis was placed on the development of heavy industry, and nearly all of the deposits of coal and iron ore lie in the north. Secondly, apart from the development of light industry in Shanghai and some coastal cities prior to the present regime, industrial development had already been largely concentrated in the north. This was partly because of the large deposits of iron ore and coal in Manchuria, but even more because the industries of that area had been extensively developed by the Japanese. Thirdly, the railway system, largely because of construction by the Japanese and Russians, was far better developed in North China than in other parts of the country. Finally, for strategic reasons it was considered desirable that new industry be located inland, and as close as possible to the Soviet Union for protection. In general, industry was largely raw-material-and-power oriented, with the precise location being determined by transportation facilities. Market orientation appeared to be of only modest importance in the establishment of new industries.

Under the first five-year plan the core of the industrial construction program consisted of 156 large projects built largely with Soviet aid. Structurally, the Chinese industrial economy was radically altered. In industry, private enterprise was virtually eliminated. In 1952 private industry still contributed 39 per cent of gross factory products, but by January 1, 1957 all private factories had been converted into joint state-private enterprises. Within the handicraft field, about 5,890,000 workers, or nearly 90 per cent, had joined cooperatives by 1957.

In the development of the second five-year plan (1958-1962) the basic concepts of the first plan were maintained. Heavy industry continued to dominate production. Certain changes, however, became evident. The Chinese government indicated that there was a need for a better-balanced development of industry in which all portions of the country should share. The development of industry in South China is stressed in this plan (36). In the second five-year plan emphasis is also placed on industries serving agriculture. It is hoped that by raising the production of these industries, agricultural raw materials will be in greater supply thus making possible a higher rate of industrial growth. The low agricultural output from 1959 to 1961, however, reduced the availability of these raw materials and industrial progress was retarded. In contrast to the first five-year plan, in which the building of huge industrial plants was stressed, the second plan has emphasized the construction of small and middle-sized plants and the modernization of the handicraft industries. It is thought that small and middle-sized plants built in various localities in order to decentralize individual plant location can yield quick results with a relatively small amount of investment per individual unit.

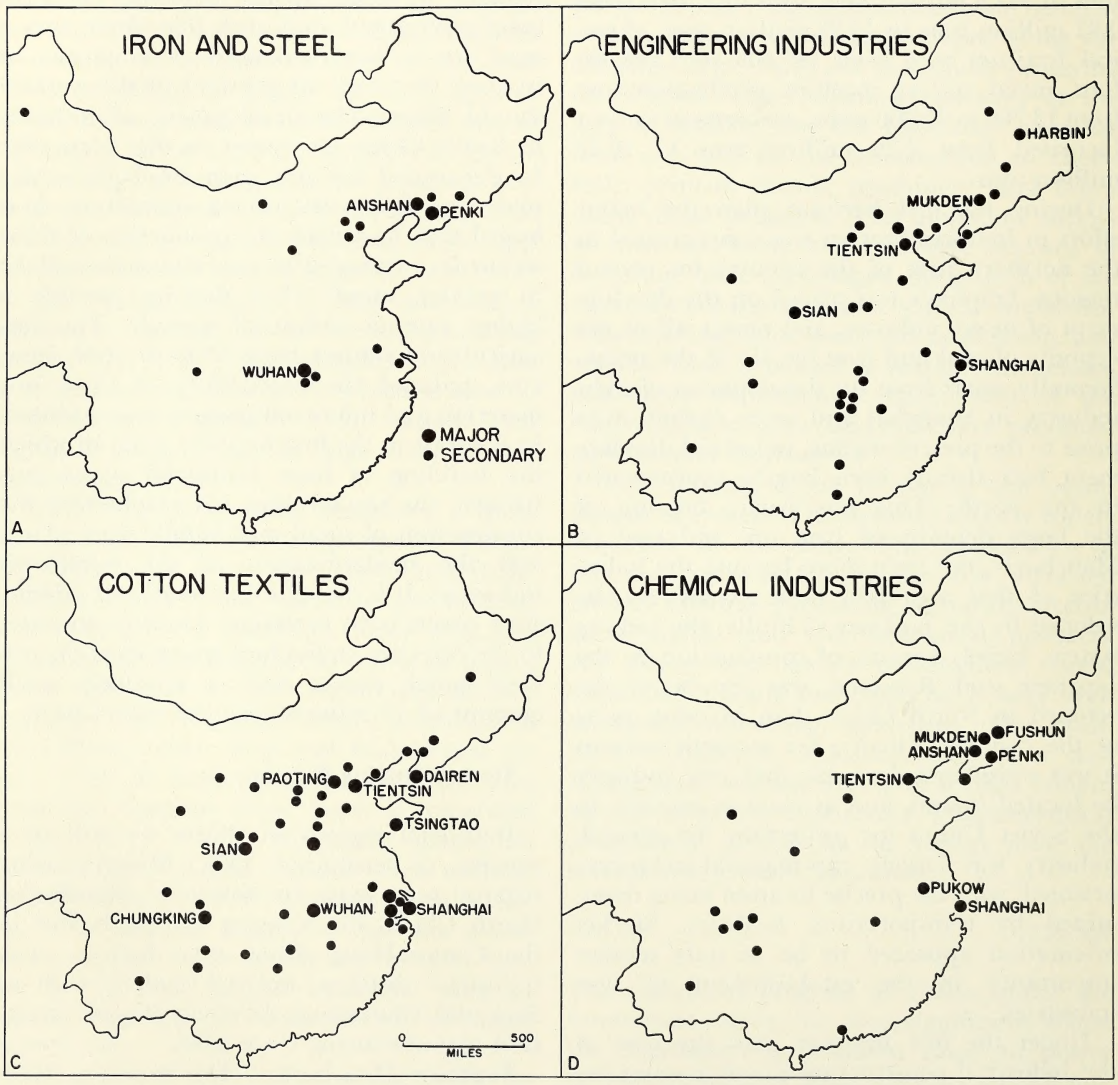
Manufacturing Regions

Industrial regions in China are still in a process of evolution (37). Manufacturing regions now exist in Southern Manchuria, North China, the Yangtze Lowlands and in the Canton-Hong Kong area. Besides these industrial districts, isolated centers, such as Sian and Chungking, have developed significant manufacturing since 1950.

Southern Manchuria. The Southern Manchuria area was one of the earliest manufac-

turing centers in China. Modern industry had its origin in the Liaoning Province at the turn of the century, coming with the construction of railroads. Initially, light industry was dominant. Most important was the processing of the region's agricultural products. Soybeans from Liaoning and farther north were shipped southward to Dairen and other centers for processing into oil and beancake for export. Many factories processed tobacco, grains, and other agricultural products.

The distinctive present-day industrial character of the region started with the development of the iron and steel industry (41). The major iron and steel center, located at Anshan, was started in 1917 by the Japanese. Two blast furnaces were in operation by 1919 and a third was added by 1930. This industry remained small until the Japanese-dominated Manchukuo regime took control in the 1930's. Two steel plants were added in 1935 and 1940 and six modern blast furnaces followed between 1937 and 1943. At the peak of production during World War II, Anshan produced 843,000 tons of steel and 1,325,000 tons of pig iron. At the conclusion of hostilities



5.2. China—Iron and Steel, Engineering, Chemical, and Cotton Textile Industries.

in 1945 the iron and steel plants were largely dismantled by the Russians and output remained small until the first five-year plan was inaugurated by the communists in 1952. Reconstruction was rapid for in 1954 Anshan produced 1,500,000 tons of pig iron and 980,000 tons of steel. By 1960 the Anshan plant had ten blast furnaces and five open-hearth steel furnaces in operation. Steel production at Anshan is now estimated to be about 4,200,000 tons or about 40 per cent of total output of China. Despite its absolute increase, Anshan will gradually produce a lesser percentage of China's steel as other regions develop an iron and steel industry. However, it will continue to be the principal iron and steel center of the nation.

A major iron and steel center has developed in Manchuria at Penki. This metallurgical center began in 1915 when two 200-ton blast furnaces went into production. Two large blast furnaces of 500-ton capacity were added by the Japanese in 1939 in the suburbs of Kungyuan. During World War II Penki produced about 20 per cent of Manchuria's pig iron output. The plant was dismantled in 1945 but restoration began in 1948 and the area has once again become a producer. Because of the low-phosphorous content of the pig iron, it is used in the production of special steels, both at Penki and elsewhere.

Iron and steel production began for the first time in 1958 in the provinces of Kirin and Heilungkiang, which previously had to obtain their steel from southern Manchuria. Although production is still quite small, the new centers include Fularki, Changchun, Kirin, Szeping, Harbin, Klamusze, Linkow, and Acheng. A steel plant has developed in Dairen using Penki pig iron and scrap from the local metal industries.

The Manchurian iron and steel industry is based on local raw materials. The Fushun coal basin has an estimated reserve of 1.5 billion tons. The main mining centers are Fushun and Penki-Yentai on the eastern margin of the basin and Fusin and Pehpiao on the western margin. Both Penki-Yentai and Pehpiao produce a high quality coking coal. Production of coal from the western basins totals about 15 million tons annually. Iron ore deposits are located in the Anshan-Kungchuling and Penki-Miaoerhkow areas. The small, rich iron ores of Anshan were first developed and were a factor in the localization of the early industry. With the decline of the Anshan deposit the low-grade ores of Kungchangling were developed 25 miles east of Anshan. The Kungchuling reserves are estimated at 800 million tons with an iron content of 35 to 40 per cent. The Penki iron and steel works are partly supplied with iron ore from Waitowshan, situated to the northwest, and partly from the Miaoerhkow deposits 20 miles south of Penki. The latter deposit is characterized by its low-phosphorous content, making it suitable for use in the Bessemer converters.

As a result of the availability of iron and steel, a wide range of metal products is produced. These industries are largely centered in Mukden, Fushun, Anshan, Penki, and cities along the Dairen-Mukden-Changchun railroad. Of these centers Mukden, the major railroad hub of the region, is the dominant industrial city.

In the industrial plans of China, high priority is given to the development of the machine-building industries. Within Southern Manchuria the manufacture of machine tools has begun at Mukden, Changchun and Tsitsihar. Heavy machinery plants are situated at Dairen, Mukden, Fularki, Anshan, Fushun, and Chinchow. Harbin is noted for production of ball bearings and electric motors, including turbine generators. China's first motor vehicle factory was constructed at Changchun in 1956. This plant has a production capacity of more than 30,000 trucks annually. Many kinds of machinery, such as power generating equipment, blast furnaces with 1,000 cubic meter capacity, open-hearth furnaces with 150-ton capacity, and coal cutting machines are now produced in China.

The chemical industry of China is still largely concentrated in Southern Manchuria. This industry has essentially come into existence since 1953. China has modern chemical plants, whose output has been expanded from 80 to over 900 kinds of chemicals. The major chemical centers in Manchuria include Mukden, Dairen, Fushun, Penki and Anshan. Most of the plants in these centers base their production on coke by-products. The chief center for soda-ash and caustic soda is Dairen.

Fertilizer is produced at Dairen, Mukden, Anshan, and Fushun. The mining and distillation of oil shale began in Fushun in 1929. Although the two oil shale plants were inactive after World War II, the communist regime rehabilitated the plants, one of which produces ammonium sulphate fertilizer as a by-product. Synthetic fuel is also being produced at Fushun through the hydrogenation of coal. Another industry associated with coal is that of carbon black, which is produced from the methane gas of the coal deposit.

The availability of hydroelectric power has also fostered industrial development. Prior to World War II the Japanese developed a considerable number of water-power sites. One of the largest was on the Sungari River, where a dam 266 feet high, and two-thirds of a mile long was built. The dam had an annual generating capacity of 563,000 kilowatts. Since 1953 at least three new hydroelectric power stations have been constructed. The hydroelectric power stations are supplemented by eight thermal stations, of which four are new. A number of industries have developed in the region because of available low-cost electrical energy. Aluminum plants are now operating at Fushun, Kirin, and Antung.

Southern Manchuria also possesses a number of other diverse industries. Because of the availability of lead and zinc, a large lead and zinc smelter is located at Mukden and a zinc smelter at Hulutao. A small magnesium plant is in operation at Yingkow. The area also has a wide variety of light industries. The textile industry is relatively small but has developed at Chinchow, Liaoyang, Harbin, Mukden, and a few other centers. This industry is largely based on cotton and flax, local raw materials.

North China. An important industrial region is developing in North China in the provinces of Hopei, Shantung, and Shansi. Within these provinces Tsingtao and Tientsin dominated the industrial output before the communist takeover. Since 1950 industrial output has not only grown greatly, but has become much more widely distributed.

The expansion of the iron and steel industry has been a factor in the industrial growth of the region. The principal centers of the North China iron and steel industry consist of the integrated iron and steel plants at Shihkingshan, on the outskirts of Peking and at Taiyuan, and the steel plants at Tangshan and Tientsin. The iron and steel plant at Shihkingshan lies twelve miles from Peking's western gates but is still within the capital's municipal borders. The plant is located on the Yungting River and a railroad spur to the Mentowkow anthracite mine. The plant was originally built during World War I and expanded by the Japanese during World War II. As a result of present expansion the pig iron capacity of the plant is about 400,000 tons, five times the production attained under the Japanese. This plant is well situated in regard to raw materials. The coking coal is obtained from mines along the foot of Taihang Mountain to the south of the plant. Coal centers include Liuhokow, Tsingsing, and, particularly, Fengfeng. Fengfeng, situated in southern Hopei on the Peking-Hankow railroad, is being developed as a source of coking coal for the industry of North China and Manchuria. The iron ore is largely obtained from the Lungyen deposits of Hopei. This is one of China's main ore deposits. It is hematite with about 50 per cent iron content. Its phosphorous content is too high for use in Bessemer steel furnaces, but is suitable for basic open-hearth furnaces.

The second iron and steel center of North China is at Taiyuan. The development of the industry here is due to the availability of coal and iron ore in the vicinity and the city's central position in Shansi. Railroad facilities are good for marketing both iron and steel as well as other steel products such as machinery. After World War II the old, half-ruined Taiyuan iron and steel plant was reconstructed and converted into a steel producer with new equipment. Industrialization was greatly intensified after 1949, and the city's population has expanded from about 270,000 to over 800,000. The iron and steel plant, in addition to the basic blast and open-hearth furnaces, produces electric steels, sheets, and structural and forged items. The Taiyuan thermal electric station, put into operation in 1954, made possible the increased production of special steels.

The steel plants at Tientsin and Tangshan have developed to supply local industries with

steel. The raw material for these plants comes not only from the pig iron, but, recently, from scrap metal as well. The capacity of these plants has been increased greatly since 1950. Other small centers of steel production in North China include Tsinan, Weihsien, Tangshan, and Changchih.

Of the individual districts in North China one of the important zones of concentration extends from Peking along the railroad through Tientsin to Tangshan in the Kailan coal basin. In this area the machinery industry has experienced rapid growth. In the past Peking was basically an administrative center. Before 1949 it was noted for handicraft trades, such as rugs, enamel and lacquerware, and light consumer goods. In the 1950's textile factories developed, and new machinery factories include the production of agricultural machinery, machine tools and textile machinery.

Seventy miles to the southeast of Peking stands Tientsin, China's third largest city. In contrast to Peking, Tientsin, developed in the nineteenth century by foreign nations, was one of China's earliest industrial and commercial cities. Tientsin grew as a natural outlet for the products of North China and Mongolia. As one of China's leading ports, Tientsin has also developed as a key industrial center. Prior to the communist regime the city was noted for its cotton and woolen mills and food processing industries. Since 1949 greater attention has been given to the metallurgical industries, including machinery and metal fabrication. Among the plants are those of motor vehicle assembly and the production of bicycles.

To the northeast of Tientsin is the coal basin of Kailan. With a known reserve of over one billion tons of bituminous coal, this area became the largest coal producing region in China by 1957. Tangshan is the industrial metropolis of this coal basin. Its industries are based largely on local power resources. Of the heavy industries, steel and cement plants are most important. In recent years metal consuming industries have increased greatly in importance.

A second zone of industrial development extends southward from Peking to Hsin-hsiang along the Peking-Hankow railroad. The dominant industry in such towns as Paoting, Shihkiachwang, Singtai, Hantan, and Chengchow is cotton textiles. This area is one of the major cotton producing centers of China and the industry is basically raw material oriented. Although the cottage textile industry was well developed prior to 1949, the factory textile industry now dominates. As in the other cities of this region metalworking industries are growing. For example, Shihkiachwang produces steam-driven locomotives. As industry has expanded, the population of the cities has increased rapidly. Hantan's population rose from 30,000 in 1949 to 100,000 in 1953 as a response to industrial construction.

A number of isolated cities in North China have increased their manufactural importance under the communist regime. Tsingtao developed originally as a port city. Precommunist industries included textiles, flour, vegetable oils, and paper. Since 1950 heavy industry has been fostered. In the northern industrial suburbs of Szefang a locomotive works has been built and at Tsangkow a new cement industry produces cement for the surrounding region. In the western portion of Shantung Province, Tsinan is an agricultural processing center. Its industrial economy is similar to that of Tsingtao in producing textiles, flour, and vegetable oils.

Yangtze Lowlands. Within the Yangtze Lowlands three districts are of significance in manufacturing. Shanghai, in the lower Yangtze Valley, provides the nucleus for a concentration of manufacturing. In the Middle Yangtze, industry has evolved in the Liang-Hu Basin within the triangle between Wuhan (Hankow-Hanyang-Wuchang), Changsha, and Nanchang. Finally, Chungking, in the upper Yangtze Valley, has developed an industrial complex.

Shanghai, located at the mouth of the Yangtze, is situated in one of the most favorable economic locations in the nation. Its position is somewhat like New York's situation in the United States. During the era prior to the communist regime Shanghai represented for the Western nations a point of access to China. This city developed initially as a trading center, but industries soon flourished. Shanghai not only had the advantage of receiving imported raw materials, but was

well located to serve southern China. Its hinterland is the 750,000 square miles of the Yangtze Basin, which contains the market demands of more than 200 million people. Prior to World War II it was estimated that Shanghai accounted for half of China's industrial output, and possessed about 43 per cent of the country's industrial labor force.

The early industries developed in Shanghai were primarily those producing consumer goods. Of these, textiles were most important, with Shanghai having two-thirds of the country's total. This industry accounted for more than half of the total industrial labor force of the city. The raw materials for the textiles were assembled largely by water transportation. Besides textiles, food processing, dominated by flour milling, was of importance. Virtually every type of light manufacturing, serving the needs of the Chinese market, was found in Shanghai. The printing industry of the nation was centered here and the city also had important shipyards and arsenal manufacture.

With the planned industrial development begun in 1949 it was visualized that industry would be more widely dispersed in China. As a result Shanghai's industry declined for a few years. However, since about 1955 the city's industry has once again increased—although with the growth of new industrial centers its relative position has declined. Nevertheless, it still has 40 per cent of the country's cotton spindles, even though the number of spindles has increased little if any since 1953. Of the 20 new textile mills started during the first five-year plan none were located in Shanghai. As in the remainder of China, the metal industries have increased in importance. Steel plants are now found in Shanghai and the industrial suburb of Maanshan, mainly serving the machine building industries of these cities. Shanghai now has a diversified industrial structure, embracing machine tools and other engineering works, chemicals and cement plants, a shipbuilding yard, and similar industry. This metropolitan area has a reservoir of 800,000 industrial workers, who have made notable contributions to the training of a modern industrial labor force for other regions. Although Shanghai is no longer the key city in China's industrial development program, it is likely to remain her leading industrial city for many years.

The Liang-Hu Basin of the Middle Yangtze is a focus for both land and water transportation routes. Besides the major east-west water route, north-south railroad lines lead to Peking and Canton. The major industrial centers are the three-city combination of Wuhan in Hupei, Changsha in Hunan, and Nanchang in Kiangsi.

The iron and steel industry began in this region at about the turn of the century. The first plant was built at Hanyang. This metallurgical plant was long the chief iron and steel producer in China proper. Although initial growth was fairly significant, production lagged in the 1930's, and in 1939, with the invasion of the Japanese, the plant was dismantled and shipped to Chungking. The site of the former steel plant is now occupied by a cotton mill.

Under the communist regime the iron and steel industry has been recreated in the Wuhan-Tayeh area. The Wuhan plant was built in the late 1950's. In 1960 one blast furnace with a capacity of 1,380 cubic meters, two coke batteries and an electric power station were in operation. A steel making unit was under construction. This plant is based on Tayeh iron ore and Fengfeng coking coal. In the future the iron ore deposits of western Hupei and the coking coals of Pingting will provide the principal raw materials.

Hwangshihkang, located on the Yangtze about 50 miles southeast of Wuhan, is a new industrial center. The city was created in 1950 out of the two riverside towns of Shihhweiyao, a former iron ore loading port and Hwangshihkang, a cement center. A new steel industry has been built on the site of two blast furnaces that were dismantled by the Japanese during the Second World War. In 1958 this plant produced 500,000 tons of steel, and with future developments will rival the Anshan establishment. This plant, based on nearby Tayeh iron ore and Pingsiang coking coal, has become the largest integrated iron and steel factory in central China. Formerly it was accessible only by way of the Yangtze River, but now the city is linked with the Hankow-Canton railway by a rail spur. This rail connection facilitates both the shipping

of coking coal from Pingsiang and the marketing of the finished steel. A third small steel center at Ocheng went into partial operation in 1958.

Besides basic iron and steel the Wuhan area is noted for its diversified industry. The chief industries of Hankow include machinery, chemicals, cement, and textiles. The industrial plants of Wushan include cotton, silk and paper mills, railroad repair shops, and a shipyard. There are also food processing factories preparing tea, eggs, tuna, and vegetable oils.

A number of other centers have developed manufacturing. Nanchang, located on the right bank of the Kan Kiang and the railroad terminus of the Chekiang-Kiangsi line, has developed a notable industrial district. Its factories produce paper, textiles, machinery, chemicals, farm implements, and foods. In northeastern Kiangsi is the world-famous porcelain center of Kingtehchen. The industry was originally based on the kaolin resources of Kaoling lying east of the city. The original deposits have been largely exhausted through centuries of exploitation. The potteries of Kingtehchen now obtain their clays from Kimen in southern Anhwei. The industry remains because of the skilled labor in the area.

In Hunan, the cities of Changsha, Chuchow, Siangtan, and Hengyang, located on the Hankow-Canton railroad or one of its major spurs, form a growing industrial district. Changsha is important in the processing of nonferrous metals, including antimony, lead and silver, and has long been noted for its handicrafts including embroidery and porcelain. Since 1949, Siangtan has become an industrial center, producing electrical goods, wire, machine tools, cement and chemicals. A cotton textile plant is also found in the city. Chuchow has locomotive and car repair shops, and Hengyang, a key rail hub, has developed machinery and machine tool plants.

In the upper Yangtze Valley, Chungking forms the center of an expanding industrial district. The industrial development at Chungking received impetus during World War II. Many industrial establishments were moved into the area from the Japanese occupied territory. In 1940, an iron and steel plant, now named the No. 101, was built at Tatukow, ten miles southwest of the city center. This plant, with a 100-ton blast furnace, two open-hearth furnaces, and a rail mill produces about 500,000 tons of steel ingots annually, corresponding approximately to its rolling mill capacity. Until the completion of the heavy rail mill at Anshan in 1953, this was the nation's leading center of rail production. Besides this plant, three other plants are operating in Chungking. Two of these produce only steel. In the 1960's Chungking will become a leading iron and steel center. Its local raw material supply will then become inadequate and iron ore will be received from the western Hupei Basin along the Yangtze and from the Tsunyi deposit along the Szechwan-Kweichow railroad. The Tsunyi area contains large deposits of iron ore and several coal deposits. Other industries in Chungking include cotton and silk textile factories, chemical plants (including fertilizer production), and a plastic factory based on gallnuts.

The lack of transportation facilities has hindered the industrial development of the Chungking District. With each new transportational development, manufacturing has expanded. In July 1952, the key railroad from Chungking to Chengtu was completed. This line, 310 miles long, provided the basic route for a new rail system in western China. Largely as a response to the rail facilities, engineering, textile, and railroad maintenance industries have developed in Chengtu. Other small industrial centers include Luchow, Neikiang, Hochwan, and Ipin. These are primarily trade centers, but have developed industries processing local raw materials, particularly foods.

Canton-Hong Kong complex. Industry in southern China is still poorly developed. Under the planned growth of the Communists, this area has received the least attention. The lack of development is in large part due to the poor transportation facilities in much of southern China and consequently the inability to utilize local raw materials.

Within southern China the major industrial zone centers on the Canton-Hong Kong area. This is the focal point of transportation for the Kwangtung-Kwangsi region. Industries have developed here similar to those in

Shanghai in order to provide manufactured goods for a large consuming area. The modern factory zone of Canton is strung along the Canton-Kowloon railroad.

A large number of light industries are established in this region. Silk, cotton, and jute textiles lead in the number of workers employed, although the porcelain and earthenware industries and the shipbuilding industry are usually more important when measured by value of product. The processing of food is still another industry. A large number of consumer items such as light bulbs, apparel, electric fixtures, and rubber goods exist because of the market. Traditional handicrafts are lacquerware and ivory engravings.

Heavy industry has not been well developed in the region. Until the late 1950's the region had limited iron and steel production. The city made steel in dozens of small craft enterprises, of which the shipyard was the largest. Kwangtung has iron ore deposits but exploitation is in an initial stage. The first plants of the modern Canton iron and steel industry went into production in 1958 and the output totaled 190,000 tons of pig iron and 42,000 tons of steel. By the end of the second five-year plan in 1962, Canton is expected to produce 600,000 tons of steel a year. The availability of iron and steel as a raw material will encourage the growth of the engineering industries.

The British Crown Colony of Hong Kong lies approximately 60 miles southeast of Canton. This city, with its large sheltered harbor and strategic location, developed primarily as an *entrepot* port. With the establishment of a communist government in China, Hong Kong attracted thousands of refugees fleeing from the Shanghai area, many of whom were industrially skilled. There was also a flight of Chinese capital and entrepreneurs to this free city. By 1960 it was estimated that the industrial labor force of Hong Kong totaled 100,000 to 125,000 persons, more than in any other city of southern China. The growth of light industries has been spectacular in Hong Kong. Of the products produced, textiles, small metal fabricated items and plastics are noteworthy. In contrast to the other mainland industrial districts of China, where raw materials and markets are almost exclusively internal, the raw materials of Hong Kong are secured largely from overseas sources and the export market is vital in maintaining the industrial growth of the city.

New industrial centers. Besides the industrial regions of China a large number of new manufacturing centers are in the process of development. Traditionally the industry was concentrated in coastal China. In 1952 the seven coastal provinces possessed 73.1 per cent of the industry.[1] As the result of the attempts to develop the nation, interior centers of industry are appearing. In the early stages of development the inland areas were greatly favored in their development. During the first three years of the first five-year plan, 55.3 per cent of the industrial investment was made inland, and 44.7 per cent on the coast, as compared with 50.2 per cent and 49.8 per cent in the previous three years of rehabilitation. Between 1952 and 1956 the inland areas increased their share of manufacturing from 26.9 to 32.2 per cent. However, it must be remembered that during this period national security considerations predominated in the establishment of many industries inland when it would have cost less to expand capacities on the coast. Beginning in 1956 a new policy was initiated to create a balanced growth between the coastal and interior areas (37).

A number of the recent locational changes are noteworthy. In 1958 the Chinese government planned a "great leap forward" in the iron and steel industry with the goal to double iron and steel production in one year from 5.35 million tons in 1957 to 10.7 million tons in 1958 (43). In order to fulfill this objective, it was decided to combine the development of the large-scale modern industry with traditional craft methods of iron smelting known in China since antiquity. A small iron furnace with a capacity of a few cubic yards can be built quickly from local materials. In the summer of 1958 about 1 million small furnaces were built in China. By the end of 1958 these small furnaces were supplying three-fourths of China's pig iron and 40 per cent of its steel. The rapid growth of small iron smelters solved

[1] The coastal provinces are Liaoning, Hopei, Shantung, Kiangsu, Chekiang, Fukien, and Kwangtung. Within these provinces three cities, Shanghai, with 24.3 per cent of total industry, Tientsin, 6.8 per cent, and Peking, 2.8 per cent, were outstanding centers.

the raw material supply problem for many steel producers and made it possible to reduce long hauls of iron.

However, this handicraft type of iron and steel industry immediately created many problems. The quality of the iron produced was poor. Iron smelted in small craft furnaces has a high sulphur and phosphorous content, making it difficult to use in open-hearth furnaces. Irregularity of production caused many difficulties with transportation, and the interruption of the flow of iron to steel plants wasted manpower. As a result, the small furnaces disappeared by the hundreds of thousands. In their place centers of small integrated iron and steel plants, including even the utilization of chemical by-products, began to appear. Thus began the concentration of the iron and steel industry in centers best supplied with raw materials, manpower, and transportation lines. In 1960 over 70 new centers of iron and steel production were in the process of construction.

Of the new centers, the Paotow integrated iron and steel plant of Inner Mongolia is of considerable importance. The Paotow steel complex is constructed along two basic lines. The one unit consists of small iron smelters with a combined capacity of several thousand tons of pig iron. The second unit is a large, modern plant with a blast furnace capacity of 1,500 cubic meters and a steel plant with 600-ton open-hearth furnaces. The iron and steel industry is based on the nearby coking coals of Shihkwaikow and iron ores from Paiyunopo. The iron and steel from this center will supply northern Shansi, Inner Mongolia, and Lanchow.

A number of other industries have developed a dispersed locational pattern. Of these the textile industry is a noteworthy example. In pre-communist China 80 per cent of the cotton textile factories were concentrated in the large coastal cities. As a result of this pattern of location the cotton textile industry was poorly developed in the cotton-growing regions. During the first five-year plan 75 cotton mills, a large part of which were built with Soviet aid, were put into full or partial operation. All the newly constructed enterprises are in the cotton-growing regions. Because of this locational reorientation, Sian in Shensi Province has become the second largest textile center in China, surpassed only by Shanghai. This textile center is raw material oriented, and a large thermal power plant has been constructed to provide power for the expanding industry. Other cities in the Sian area are also developing textiles. For example, Sienyang, ten miles northwest of Sian, was raised to the status of a city in 1952 in connection with the construction of large cotton mills. Sienyang receives its power from the Sian plant, with which it is connected by a transmission line. The textile industry, developing at a rapid rate, along with food processing, is one of the chief branches of light industry.

INDIA

The development of a modern industrial economy in India has not been rapid. Prior to World War I British capital dominated the establishment of manufacturing firms. Growth of modern industry was, however, largely limited to textile production. In general, British policy discouraged the expansion of Indian manufacturing through a variety of restrictive economic and political controls. Until World War I India depended on imports to satisfy her small market for manufactured goods.

World War I, when imports were largely not available and the demands for Indian raw materials increased, provided an incentive for the growth of domestic industry. Between the world wars a number of industrial advances were achieved, although progress was not rapid and was limited to a few types of manufacturing. One of the significant developments was the expansion of Jamshedpur as an iron and steel center (45). Other industries that grew significantly were sugar refining and cement. There was also a growth in the consumer goods industries, including textiles, foods, and household articles. The consumer industries were aided in their expansion by the nationalist boycotts of British goods. A number of the new industries based on Indian raw materials were also protected by the government.

Regardless of the expansion, India was still dependent on many imports at the beginning

of the Second World War. Although imports were limited during the war years industrial growth was not rapid during this period. The economic climate of India did not favor rapid industrialization. During the war period and in the early postwar years, industrialization was motivated by scarcities and world inflationary trends which made imports even more costly.

At the time of the creation of an independent India in 1947 it was recognized that industry had to be developed if economic stability was to be achieved (52). In order for industrial growth to occur one of the first prerequisites is the availability of power. India has made considerable progress in solving this problem. The coal resources of India are large and output has risen from 30 million tons in 1948 to nearly 50 million tons in 1960. Although the coal deposits are widely scattered the coking coal is largely limited to the Damodar River valley of Bengal-Bihar. Petroleum reserves are greatly limited. Nevertheless the petroleum refining industry has been expanded. The Digboi refinery, located in the oil fields of Assam, has been doubled in capacity and foreign companies have built two refineries at Bombay and one refinery at Vishakhapatnam to process Middle East oil. These plants cost $126,000,000, the largest foreign investment ever made in India. India now has a refining capacity of about 33 million barrels annually. The electrical power potential of India is great, and since 1947 the developed capacity has been more than doubled. When independent India was formed there was essentially no developed water power; in 1960 it represented about 40 per cent of all electricity used. About three-fourths of all electricity generated in India is used in factory manufacturing.

In order to coordinate the economic development of India the first five-year plan was initiated in 1951 (53). As a result the course of industrial development in India has been greatly influenced by state planning. One of the immediate goals was to increase the investments for the production of capital goods. This action was instituted in order to bring about a better balance in production, since output of consumer goods had been previously stressed. Under the first five-year plan (1951-1956) nearly half of the total investments in manufacturing was allocated to the metallurgical industries and petroleum refining and about one-fourth was used for the development of the engineering and chemical industries. Only a small proportion of funds was directed to the consumer goods industries. The investments in the consumer industries, including the cottage industries, were primarily for modernizing these endeavors. During the first five-year plan, production of capital goods rose 70 per cent from its modest 1951 level, while the output of industrial materials, as well as consumer goods, increased by about one-third. The aggregate index of industrial production rose by 38 per cent.

The second five-year plan (1957-1961) continued the basic objectives of the first. Since 1956 the engineering and chemical industries have experienced a significant rise. The deemphasizing of the consumer goods industries continues. For example, production of woven cotton fabrics has been essentially stable since 1952. Although progress has been made in the expansion of Indian industry, many problems are still evident. Hampering progress has been the inadequacies of transportation for the movement of raw materials and finished goods. The lack of capital has frequently delayed industrial projects. At times, planned-for foreign aid has not been forthcoming, and the country's exports have failed to respond to government stimuli. In most industries, skilled technicians, heavy machinery, and progressive management are in short supply. Regardless of the problems, progress has been made. In 1960 the production of machinery, including electrical, was well over twice the level of 1953. However, these industries still account for less than ten per cent of industrial production. The textile industries constitute about 40 per cent of total industrial production. Industry still reflects a structural imbalance. Although the capital goods industries are rising more rapidly than consumer goods industries it will be many years before a sound industrial economy in India is achieved.

Structure of manufacturing. The manufacture of textiles is the largest industry in India. Of the branches of the textile industry, cotton dominates. Within the cotton textile industry there are two important sectors, the

factory looms and the cottage handlooms. It is estimated that there are still in existence more than 2 million handlooms, possibly employing several million workers. Within the second five-year plan provision has been made to change 15,000 to 20,000 handlooms each year to power-driven looms. However, no drastic conversion is contemplated, since it is felt that unemployment and hardships would result. The Gandhian philosophy that handloom weaving leads to economic self-sufficiency and provides both urban and rural employment is still very much in favor in India. In 1949 it was ordered that one-half of the textiles bought by the government of India should be handwoven. The industry was also given the privilege of producing 40 per cent of the saris and dhotis. The All-India Hand-Loom Board established in 1952 is supervising the organization of these weavers into cooperatives. Tax exemptions, direct financial aid, and rebates on the sale of handwoven fabrics have been granted.

There are about 460 cotton factories with a labor force of approximately 935,000 workers. This is about 40 per cent of the total factory labor force in India. The industry possesses 12,800,000 spindles and over 200,000 looms, and consumes about 5 million bales of cotton annually, of which 3 million are produced in India. The annual output of cloth is between 4,500 and 4,800 million yards, of which between 800 and 900 million yards are exported. The output of the industry expanded rapidly during World War II as demands increased; at this time the multiple shift system was employed to increase output. Since 1945 expansion of the industry has been modest. Although the export market has declined, the expanding domestic market has favored some growth.

Of the other textiles, jute is the most important. About 110 factories, concentrated in West Bengal, have a capacity to consume 7 million bales of raw jute annually. The industry has been declining since 1950, from a number of factors. Indian jute is of poor quality and there is a serious problem in marketing the product. Many of the plants are antiquated and have the difficulty of competing with the more modern factories of Pakistan, the Philippines, South Africa, Brazil, and Japan. Without a revitalizing of this industry its future appears bleak.

The development of the iron and steel industry has received a high priority in India's planned economy. Under the first five-year plan, steel production rose from 1,524,000 to 1,766,000 tons under private enterprise. In the second five-year plan it was decided to expand the output of private companies and establish three new state enterprises. The Tata Iron and Steel Company plant at Jamshedpur has had its steel capacity increased from 750,000 to 931,000 tons annually. The capacity of the Indian Iron and Steel Company's plants at Burnpur and Asansol has been increased from 225,000 to 300,000 tons and plans have been formulated to further expand output to 620,000 tons of steel and 500,000 tons of pig iron. The Mysore Iron and Steel Company at Bhadravati has expanded its steel capacity from 40,000 to 100,000 tons. The government-owned mills were built by foreign technicians. (The Rourkela plant in Orissa was built with German assistance, a second plant at Bhilai in Madhya Pradesh by Russian assistance, and the third at Durgapur in West Bengal by British technicians.) These three plants, each with a capacity of about 1 million tons, were completed by 1959. The development of these plants illustrates the fact that, given the present state of Indian industry, there is need for both foreign financial aid and foreign technical knowedge if the country is to develop industrially.

The development of other metallurgical industries has been less rapid and a deficiency exists in most other metals. A single copper smelter and one small lead refinery are located in the Bengal-Bihar region. The low reserves of domestic ore do not hold much hope for an expansion program. The aluminum industry gives more promise of becoming a major producer of metal. There are extensive bauxite deposits in India and the availability of electrical power gives a sound foundation for its growth. There are three centers of production. One is located at Alwaye, based on local hydroelectric power from Pallivasal. Another is situated at Jaykaynagar, near Asansol, based on low-cost thermal power. The government is expanding the industry, and a new reduction plant has been built at Sambalpur, Orissa,

designed to utilize the low-cost hydropower from the new Hirakud Dam. Production of aluminum is now about 8,300 tons annually.

The machinery and electrical engineering industries are in the initial stage of development. Products produced prior to 1950 were basically consumer items such as hardware, simple agricultural implements, and small tools. Under the five-year plans a number of government plants have been built to produce locomotives, railroad passenger cars, telephone and telegraph equipment, batteries, diesel engines, electric light bulbs, sewing machines, bicycles, motor vehicle parts, and radios. Complicated machinery production such as machine tools or textile machinery is still in a state of infancy, and the nation must import most of what it needs.

The production of chemicals has risen steadily under the five-year plans. With the attempts to increase soil productivity, there has been a growing demand for commercial fertilizers. The output of superphosphate began in India during World War II. By 1949 the output of fertilizers had increased to 46,000 tons of superphosphate and 55,000 tons of ammonium sulphate. The completion in 1951 of the Sindri fertilizer factory, 15 miles from Dhanbad, the largest of its kind in Asia, marked a new stage in development. Indian output of ammonium sulphate rose to 400,000 tons by 1955 and has remained at about this level.

A number of other chemicals are produced. The soap industry is based on domestic supplies of vegetable oils, tallow, and other oils. Imports of some alkalis and coconut oil are still necessary. The nation is now self-sufficient in soap, but consumption is at a low level. This industry is located primarily in Calcutta, Bombay, and Kerala and is thus market-oriented. Other chemicals include dye and tan stuffs, paints and varnishes, matches, cosmetics, and drugs. The heavy chemical industries are in an initial stage of development. The sulphuric acid industry has developed in the textile centers and at Asansol, Jamshedpur, Belagola, and Alwaye.

The cement industry was one of the early industries developed in India. Since 1915 the capacity of the industry has doubled itself every decade and since 1951 the rate of growth has been even greater. The expansion of the industry is handicappd for lack of satisfactory limestone deposits, the basic raw material. Nevertheless, output of cement has risen from 1 million tons in 1936 to 1,600,000 tons in 1948, and to over 6 million tons in 1960. The industry employs about 40,000 workers. As industry expands and the level of living rises the demands for cement increase. The per capita consumption of cement in India is still only about 27 pounds in contrast to 400 to 500 pounds in the United States.

Manufacturing Regions

Within India manufacturing is concentrated in a small number of areas (49). The Bengal-Bihar area has two industrial districts —the Chota Nagpur heavy industry area of Bihar, and the Calcutta area, with its industry strung along the Hooghly River of West Bengal. The Bombay-Sholapur district is noted for cotton textiles, chemicals, and light engineering products. The Ahmadabad-Surat industrial area concentrates on the output of cotton textiles and allied chemicals. In southern India the Madura-Coimbatore-Bangalore area is noted for textiles and clothing, and in the Central Ganges area textiles and food processing are predominant.

Bengal-Bihar Region. The core of the Bengal-Bihar Industrial Region lies within the triangle formed by Calcutta, Jamshedpur, and Asansol. Of the industrial cities, Calcutta occupies a prime position. The industrial growth of Calcutta is directly associated with its location as the nation's leading transportation center. It is not only India's leading port, but is the hub of a railroad network linking the city with a vast hinterland.

Of Calcutta's industries jute occupies a dominant position. There are about 95 mills out of a national total of 110, employing 300,000 workers. The mills are strung along the river, with notable concentrations in Howrah and Bhatpara. The jute industry has a long history, with the first mill dating from 1855. Calcutta represents a break-in-transportation point in the establishment of jute manufacturing. Jute is produced north of Calcutta, and most of it is exported. By 1910 Calcutta surpassed Dundee, Scotland as a jute

manufacturing center, and manufactured jute is now one of India's leading exports in value, being about five times that of raw jute.

With the partition of India and Pakistan, which created the provinces of East and West Bengal, about 80 per cent of jute acreage and output was acquired by Pakistan. Although industrial backwardness and economic poverty prevent the rapid development of jute manufacturing in East Bengal, Pakistan is naturally disposed to industrialize in order to retain the profits of manufacture. This has given rise to some friction. India has attempted to increase the acreage of jute. Trade restrictions have also been imposed from time to time to preserve the industry. All of this bodes ill, in view of the vulnerable nature of the monopoly. Bulk-loading and substitutes have already made inroads in the industry, and jute is being introduced into other tropical countries. Finally, the cheapness of labor, a prime factor in the localization of industry in Calcutta, is becoming less significant in view of the general rise of Indian labor costs. Within the Calcutta area, cotton textiles are increasing in importance, but with a labor force of about 30,000, they are much less important than jute.

Diversified engineering and metallurgical industries are also important in Calcutta. Machinery for the jute mills and a variety of light fabricated products are produced. A recent development includes the rolling of aluminum sheets and bars from ingots at Belur. Railway workshops, ship repairing, motor assembly, and allied industries are important. These industries exist not only because of the local Indian market but also because of the availability of coal from the Asansol-Raniganj fields and iron and steel from Jamshedpur.

To the west of Calcutta the area lying between the Damodar Valley coal fields and the Bihar-Orissa iron ore mines is the leading mineral and metal region of India. The leading industrial center of Chota Nagpur is Jamshedpur, which possesses the largest iron and steel works in India and among the largest in non-Soviet Asia (47). Production started in 1911, and the plant, representing more than $100,000,000 in capital investment, is owned entirely by Indians. The locational advantages for the plant are striking. The rich 60 per cent hematite ore comes 45 miles from Gorumahisani in the Singhbhum District; coal is brought 115 miles from Jharia, and dolomite flux is transported 40 miles. Manganese is nearby. The assembly cost of raw materials is about one-half that of most plants in the United States and Europe. In the initial operation of the plant, American and European technicians played important roles. Now there is a body of Indian technicians and mill workers, and a modern city has grown up around the plant. As a result of available local iron and steel, steel-consuming industries such as tin-plating, agricultural implements, and small metal products have located in the city of Jamshedpur.

The Asansol and Durgapur area forms the third concentration of industry in this region. An early iron industry began in the 1880's based on local low-grade laterite and ironstone, flux, and fuel from the Raniganj coal field. The local resources were too limited and of too low a grade to be long utilized. However, once the industry was started, creating a skilled labor force and bringing about invested capital, the area turned to nearby sources of raw materials. The modern iron and steel industry is based on the utilization of the high-grade iron ores in Singhbhum and the superior coking coal from the Jharia field. The presence of good refractory clay and the availability of pig iron and ingot steel—as well as thermal electric power from coal—has attracted a large variety of industries manufacturing iron-foundry and steel rolling-mill products, locomotives, aluminum products, nitrate fertilizer, firebrick, and other ceramic products.

Bombay-Sholapur area. The Bombay-Sholapur industrial area is dominately a textile region. The cotton mills are strung along the western railway from Bombay across the Western Ghats to Sholapur. The small area of Bombay city and the industrial suburbs surrounding its harbor has the greatest concentration of cotton mills. The early localization of this industry in the Bombay area was due to a series of favorable geographical factors. A major cotton growing area of India lies in the region, making raw material readily available. Bombay, being a port city, was favorably located to import machinery, particularly from

Great Britain. At the same time its coastal position facilitated export trade. The early growth of the Indian textile industry was largely based on a thriving export trade with Japan and China.

With the rise of the Japanese and Chinese textile industries after 1905, the export market was greatly diminished. However, as the export market declined the domestic market increased. Bombay as the hub of western India's railroad network was well situated to supply the nation with textiles. The area also possessed a large labor supply, and the Parsi industrialists invested heavily in the industry. Originally the industry was powered primarily from imported coal, but gradually coal was replaced by electricity produced in the Western Ghats (56).

The Bombay state still has over half of India's textile production, but its position is gradually declining. Newer centers located at interior positions that are market oriented are growing, to the detriment of the Bombay area. The Bombay cotton producing area is being encroached upon by the production of food crops, causing the supply of cotton to become somewhat limited. The industry is also handicapped by high overhead in the intensively developed area and competition in the immediate markets from textile imports entering the port. Bombay area yarn is rather coarse and the cloth can only be exported to the low purchasing-power markets, such as Southwest Asia and East Africa. The textile industry in the Bombay area does not have a particularly promising future.

After textiles the engineering industries are most important, primarily concentrated in the city of Bombay. These industries exist principally to serve the large urban market, and especially the demand for machinery by the textile mills. Their expansion is handicapped by the lack of basic metal, particularly iron and steel in the area. Other important industries include food, drugs, and chemicals, and a host of consumer goods industries catering to the metropolitan market.

Madura-Coimbatore-Bangalore area. Manufacturing in southern India is characterized by the production of light consumer goods. Until the development of water power in Pykara, Madras in 1932, and Mysore in 1947, industrialization was greatly limited. Progress has been rapid since 1947, and industry is now located in a considerable number of urban centers. The textile industry is most important, centering in the Tamilnad cities of Coimbatore and Madura. Spinning is concentrated in Coimbatore, supplying the handlooms of Madura and other cities. The growth of modern textile factories illustrates the rise of regional centers of production made necessary by the vast size and population of the country.

The rise of Coimbatore as the chief textile center of the region is based upon its central location in regard to a supply of raw cotton and nearby Pykara hydroelectric power. Other factors favoring industry are its local labor supply, significant market, and capital. Besides textiles the town is also noted for its coffee mills, tanneries, oil presses, and a large cement works. Under the stimulus of governmental and private auspices, and with the use of abundant hydroelectric power, Bangalore has become a center for textiles, leather, soap, pharmaceuticals, electrical goods, machine tools, and aircrafts.

The south Deccan is important for a number of mineral resources. Hematite iron ore from western Mysore is smelted at Bhadravati with the aid of charcoal and hydroelectricity. In view of the lack of coking coal in the region, the development of a small, but important iron and steel industry in Bhadravati is noteworthy.

Ahmadabad-Surat area. The area extending from Surat northward through Broach and Baroda to Ahmadabad is one of the leading cotton textile regions of India. Of these textile centers, Ahmadabad dominates. The first mills were opened in the city about 1860. Progress has been steady and the city now has more mills than Bombay, though the Bombay units are larger. The modern growth has been greater than in Bombay and factories are thus more up to date. The Ahmadabad area possesses further advantages over Bombay in its cheaper land, and labor, and available local raw materials. A larger proportion of Ahmadabad's production is in finer textiles than is that of Bombay.

Broach, Baroda, and Surat are less important centers of textile production. Within Surat the

old gold and silver thread crafts and silk weaving still persist. There are over 50,000 handlooms, besides the modern textile mills. In addition to textiles the area has chemical and pottery industries. The chemical industries are directly related to the textile industries in the preparation of bleaches and dyes.

Central Ganges Region. Within the Central Ganges Valley the industry is small except in the great industrial city of Cawnpore. Modern factory industry has tended to concentrate in the southern and western portion of the Central Ganges area. In the smaller centers such basic industries as milling, food processing, and textiles predominate.

Cawnpore has evolved as a distinct industrial node. Manufacturing is highly diversified. It is the largest leather and woolen producing center of India, but it also possesses flour mills, sugar refineries, cotton factories, chemical works, and numerous factories producing other small consumer goods. This is one of India's oldest industrial cities, the first modern textile mills having been built in the 1870's. Cawnpore is one of the few cities in the Ganges area where manufacturing is the dominant economic activity.

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CHAPTER SIX

THE SOUTHERN CONTINENTS

The growth of manufacturing in Latin America, Africa and Australia has occurred largely in the twentieth century. In each of these areas the processing of local raw materials was important in the early stages of industrialization. Complex industrial regions are now evolving in each of the continents. Nevertheless, wide variations in the industrial economy still persist. Certain countries such as Paraguay, Ghana, Republic of the Congo, and Ethiopia have only the most rudimentary manufacturing industries. Other countries such as Argentina, Brazil, Union of South Africa and Australia have made great progress in developing a manufactural economy.

LATIN AMERICA

Industrialization in Latin America was late in its development. Four major difficulties retarded the growth of an industrial economy (6). Of these factors, the generally prevailing poverty and widespread illiteracy were major handicaps. The market for manufactured goods has been restricted because of the low purchasing power of the vast majority of the population. The high rate of illiteracy made the training of a large labor force difficult. The second handicap to industrial advancement is related to the traditional attitude of the well-to-do populace. In preindustrial Latin America prestige was gained largely by owning land. The investment of capital in industry was foreign to an accepted way of living. This attitude is changing in the larger cities such as Buenos Aires and São Paulo. However, even today, industrialization must, to a considerable degree, depend on foreign capital. Under present circumstances this means investment from abroad by individuals or corporations who are willing to risk capital in the hope of large and relatively quick returns.

The third handicap to national self-sufficiency is also related to the preindustrial economy. Manufacturing normally functions most effectively when raw materials can be secured at the lowest possible price in order to produce large quantities of goods at the

lowest cost per unit. In Latin America a common idea has prevailed that all countries must produce the products that are needed. For example, the government of Argentina has subsidized its steel industry, although the industry is based on imported raw materials, resulting in high-cost steel. There has been little cooperation in Latin America between countries for the interchange of commodities. Finally, the lack of an adequate transportation system has handicapped growth. The pattern of isolated clusters of economic development still characterizes the continent. The railroad lines are in general poorly constructed and poorly integrated with the population centers, making the movement of goods costly. Possibly, the highway system is even more poorly developed. As a consequence the local high-cost small factories and workshops are protected from the competition of low-cost goods from large-scale factories.

Although these handicaps continue to persist, varying from country to country in their effectiveness, Latin America has witnessed a significant growth in manufacturing. Besides the initial processing of agricultural and mineral products, the first moderate stimulation to manufacturing came during World War I (2). The Latin American countries were not able to obtain necessary imports, primarily from Western Europe. New factories producing consumer goods were built in many of the countries. However, the impetus of the war proved inadequate after 1920 to divert sufficient capital from the traditional industries of agriculture and mining to produce a



6.1. Manufacturing Regions of Latin America.

strong manufacturing economy. In general during the 1920's and 1930's products were inferior and limited in quantity. Countries still found it more convenient to export one or several raw materials and receive payments for them in a wide variety of consumer goods. Inter-American trade had not developed to any extent.

The Second World War once again created an economic environment encouraging industrialization for products which could not be imported from Europe or the United States. Manufacturing expanded in all countries. The less advanced nations became nearly independent in respect to various consumer goods. Other countries such as Argentina, Chile, Brazil, Colombia, and Mexico have progressed far beyond the stage of establishing basic industries in food and textiles and are expanding their manufacturing to include complete or partial sources of supply for such complicated items as machinery, construction equipment, and chemicals. These countries have witnessed the growth of a large number of medium-sized, and some large, factories. These plants are significant to the economy of the countries because they are manufacturing consumer goods for a national market and are in a competitive position in regard to world trade. They also produce a diversified variety of goods representing a cross section of the consumer goods demanded by the population.

The trends that began in World War II have continued to the present. During recent years the manufactural experience gained in these embryonic industries has provided a small but expanding group of technically skilled workers. As a result of a growing recognition of the advantages of industrialization definite plans for advancement have developed in many countries (10). Through government and private organizations, national associations of industrialists, and interregional pacts, a program of national industrialization and the means of achieving its goals have been formulated within most countries.

Brazil

Manufacturing has increased tremendously in Brazil since 1940. It now employs about 15 per cent of the labor force and ranks with agriculture as one of the two major branches of the economy. The growth trends in Brazil are a response to a number of factors. The domestic market has expanded greatly due primarily to the higher purchasing power of the population. The critical shortages of manufactured goods during World War II created a domestic atmosphere favorable to the growth of manufacturing. Partly as a result of an expanding population and partly due to increased mechanization in agriculture —which displaced farm workers—a large potential labor force for industry has been created. Manufacturing was also encouraged in its development by the increased urbanization of the population.

The large-scale investment in manufacturing is a response to a complex of factors. These include an improvement in trade relations, the exchange rate stabilization policy, and import selection designed to intensify domestic manufacturing. Foreign capital, in the equivalent of billions of dollars, has been invested in Brazilian industry. As a response to these investment trends it has been possible to import raw materials and equipment at relatively stable prices, at a time when domestic prices were rising.

Location of industry. The main manufacturing zone of Brazil lies in the southeast with the principal axis between Rio de Janeiro and São Paulo. About three-fourths of the manufacturing is located in the Federal District and the states of São Paulo, Minas Gerais, Rio de Janeiro, and Espirito Santo. The leading industrial cities include São Paulo, Rio de Janeiro, Volta Redonda, Bello Horizonte, Campos, Ribeirao Preto, Limeira, Campinas, and Sorocaba. This area possesses many advantages for manufacturing. The population is largely of European origin with a heritage of industrial aptitudes and skills. It is the most densely populated portion of the country and thus provides the greatest market. This portion of Brazil is the only section that has a well-integrated network of railroads making possible the easy assemblage of raw materials and the marketing of finished manufactured goods. The coastal position provides access to both Brazilian and foreign raw materials and markets.

Within this region São Paulo is the leading

manufacturing node. Between 40 and 50 per cent of Brazil's industry is situated in the urban area. It is noted not only for its large concentration of industry but the variety of goods produced. The industries include textiles, apparel, shoes, foods, chemical products, electrical goods, machinery, metal fabrication, and a host of others.

This center possesses some unique advantages for the growth of a manufactural economy. It has been encouraged by special subsidies from the federal government because of the strong political influences of this area. These advantages included a 2 per cent tax on all goods handled at the ports of Brazil except Manaos on the Amazon and Santos, the port of São Paulo. This gives São Paulo a considerable advantage in the assemblage of raw materials and the export of finished products. São Paulo has been able to attract American capital, and over $600,000,000 has been invested in the region. This is about 60 per cent of all American investment in Brazil. It stands first, also, in the amount of domestic capital invested in manufacturing. São Paulo is centered in a raw material-producing area of Brazil. Finally, hydroelectric power is available in large quantities from the adjacent rugged and rainy eastern mountains.

Industries. As is traditional in Latin American countries, the consumer goods industries were the first to develop in Brazil. Food processing and textiles still dominate, representing nearly 60 per cent of the gross value of industrial production. Nevertheless, the relative importance of the heavy and capital goods industries has increased greatly since 1940.

In the growth of the capital goods industries the establishment of a domestic iron and steel industry was considered of the utmost importance. The construction of the initial plants began in 1942 under a loan and technical assistance from the United States. This plant, located at Volta Redonda in the Paraiba Valley northeast of São Paulo, produced its first steel in 1946. The initial capacity of the plant was 300,000 tons annually, but capacity has gradually been raised to 1,250,000 tons. It is now the leading iron and steel center in Latin America.

The resource base of this plant is good. The iron ore comes from Lafaiete in Minas Gerais, and the manganese from the same area. The limestone is quarried in the western part of Minas Gerais. The Rio Paraiba provides an adequate water supply for the steel industry. However, coal is lacking in the area. Southern Brazil possesses some low-grade coal which must be pulverized, washed, and made into briquettes before it can be coked. Brazilian coal makes up only about 30 per cent of the coal consumption of Volta Redonda. The remainder, about 400,000 tons annually, comes primarily from West Virginia. In order to secure continuous delivery of coal the railroad from Angra dos Reis to Volta Redonda has been reconstructed, making possible the movement of this heavy bulk fuel. The location of the plant at Volta Redonda was planned to be at a mid-point between domestic and imported raw materials, and at a crossroads position of roads and railroads giving easy access to the two largest markets for steel in Brazil —Rio de Janeiro and São Paulo. These two centers consume about 75 per cent of the country's output.

As the demand for steel has increased, a number of other iron and steel centers have arisen. A 500,000-ton steel mill, that is market oriented, has been built at Piacaguera, São Paulo. In 1958 the construction of a 350,000-ton steel mill was begun at Ipatinga, Minas Gerais, by a joint Brazilian-Japanese group. Another iron and steel mill has been built at Santos that is oriented to the importation of foreign coal.

With the growing availability of iron and steel, the metal consuming industries have expanded. A wide variety of machinery is now produced in Brazil. A machine tool industry is in its initial stages of development, with lathes being the main type of tools produced. The electrical machinery industry is of some importance. Not only are electric motors and turbines produced but such complicated equipment as high-grade magnetic components for electronic appliances.

The motor vehicle industry has experienced significant growth in recent years. Until 1955 the automotive industry was based on the assembly of foreign cars and trucks, and the manufacture of parts was limited. In 1956 the government established an industrial planning

group to develop the industry. As a consequence the output of motor vehicles doubled in 1957. Brazil's first passenger car—the first four-door sedan produced in Latin America—was made by the DKW-Vermag Company. Volkswagen passenger car production began in January 1959 at a daily rate of 20 cars. The manufacture of Dauphine cars also began in 1959. General Motors, Ford, and Willys-Overland are among the leading American automotive producers in Brazil. Brazil's annual production has now reached about 100,000 vehicles. A noteworthy trend has been the standardization in the automotive industry. Several auxiliary industries to the motor vehicle industry have developed. For example, the forging industry produces such items as axles and gearboxes. In turn these auxiliary industries support still other industrial endeavors, such as railway equipment and shipbuilding.

A small shipbuilding industry is evolving in Brazil. In 1958 the government established a committee to develop this industry. Construction of a shipyard in the harbor of Rio de Janeiro with an annual capacity of 60,000 tons was begun in December 1958 by a Japanese firm. Early in 1959 the construction of a 40,000-ton shipyard was begun near Angra dos Reis, about 75 miles south of Rio de Janeiro, by a Dutch firm. Other yards are being built by American and German capital. In order to encourage the industry a foreign exchange subsidy provides for the importation of materials for the new industry.

A wide variety of electrical household appliances are now produced in Brazil. Although the industry is of recent origin is has already reached an advanced stage. During recent years this industry has produced Brazil's entire requirements, and imports have virtually ceased. In a number of these industries capacity is far in excess of demand. For example, the washing machine industry has a capacity of 200,000 units annually, although output is only between 50,000 and 60,000.

The chemical and pharmaceutical industries are expanding rapidly. Although substantial quantities of chemicals must still be imported, self-sufficiency is expected within a decade. A wide variety of products is produced, including sulphuric acid, caustic soda, solvents, DDT, and alcohol. The petrochemical industry has developed recently. The industry is centered around the refineries at Cubatao and at Duque de Caxias. The pharmaceutical industry is located primarily in São Paulo, where such products as vitamins, mineral supplements and hormone steroids are produced. The fertilizer industry is expanding as a result of the rapid rise in domestic demand. The phosphate industry is best developed and now has an output exceeding 250,000 tons per year.

Argentina

Argentina is one of the most highly developed countries of Latin America. Traditionally Argentina was a large-scale producer of agricultural and livestock commodities. Until as late as 1880 the domestic economy was based on the export of foodstuffs and raw materials and the import of the necessary manufactured goods from Europe and North America. For example, in 1880 Argentina exported wheat and in turn imported nearly 2,500,000 pounds of flour, producing almost no flour domestically. Gradually, manufacturing evolved and by World War I Argentina had developed a small but significant industry which processed local agricultural commodities.

During World War I the import of foreign manufactured goods was greatly curtailed. As a result Argentina turned to the development of domestic manufacturing. Capital goods, particularly machinery, were imported, and factories built. To protect the infant industry a protective tariff was enacted. By 1920, shoes produced from domestic leather, could compete with expensive imported shoes. Similarly the woolen industry was so far advanced that it could compete with all but the finest worsted goods from Great Britain. As a result of an expanding domestic market Argentina's manufacturing industries continued to grow during the interwar years, but the nation was still dependent on imports for many manufactured goods.

With the outbreak of World War II imports of industrial raw materials, fuels, and manufactured goods, particularly capital goods and consumer durables, declined sharply. Continental Europe as a source of imports was

inaccessible and the United States and United Kingdom could not supply Argentina's requirements. At the conclusion of hostilities, the government initiated policies in an intensified effort to industrialize the country. The first five-year plan (1947-1951) subordinated agriculture to industrial objectives. It was envisioned that the country's economy could be changed to one where industry and agriculture could be on an equal basis. A basic aspect of the program was the halting of imports of manufactured goods and of most industrial raw materials.

Although some industrial progress was made during the Peron era, the second five-year plan as such was abandoned by the provisional government established in 1954. Governmental surveys revealed that the nation's industry was characterized by obsolescent capital equipment and declining productivity. Periodic shortages of raw materials and fuels were also hindering industrial growth.

The provisional government instituted a number of measures to rehabilitate manufacturing. One of the first actions was to reestablish a free foreign exchange market and to liberalize import restrictions. The government secured in 1956 a loan of $100,000,000 to rehabilitate the state-owned railroads. In order to supply greater quantities of power from domestic sources an intensive petroleum exploration program was inaugurated, as well as the construction of oil and gas pipelines and the enlargement of refinery capacity. The thermal power facilities of Buenos Aires, where electric power deficiency was most serious, were enlarged, and additional hydroelectric facilities have been expanded in the western mountains. As a response to these activities industrial growth has occurred in recent years.

Location of manufacturing. The principal industrial area of Argentina is located in Buenos Aires and its immediate region. Buenos Aires assumed a dominant position from the earliest period in the industrial growth of the nation. This concentration of industry is based on a number of factors. This city possesses the advantages of a coastal location. Because Argentina has to import a large percentage of its industrial raw materials and coal as well as much of its capital goods a coastal position is greatly to be desired. Of all coastal cities in Argentina, Buenos Aires is the most centrally located for easy access to the largest domestic consuming area. Within the metropolitan district live five million people with the greatest consuming capacity in the country. The nation's railroad transportation network centers on Buenos Aires. This city is most accessible to the principal sources of domestic industrial raw materials. Other places along the coast are either too far from the major markets and raw materials of the Pampas or are separated from them by the marshlands of the eastern Pampas. Cities inland from Buenos Aires on the Paraná River may be more centrally located within the nation, but they suffer the disadvantage of being inaccessible to large ocean steamers. As a result Buenos Aires is best located to serve the Pampas while at the same time having access to overseas areas.

Manufacturing in Buenos Aires is highly diversified. Industries based on domestic raw materials were established first and still predominate. These include meat-packing, flour milling, quebracho extraction, leather processing, and the production of wines, vegetable oils, dairy products, and other foods. The textile industries were also among the first to be established. A wide variety of newer industries, based at least in part on imported raw materials and fuels, include machine tools, machinery, chemical products, plastics, rubber, and electrical equipment.

There are a number of lesser centers of manufacturing in the Pampas. These include such Paraná River cities as Rosario, San Nicolás, and Paraná, and Santa Fe on the Rio Salado. The industrial structure of these cities resembles Buenos Aires, but on a much smaller scale. Bahia Blanca is the major port of the southern Pampas, and is noted for its food processing, tanning, wool processing and oil refining.

In northwest Argentina a number of industrial cities are rising. Córdoba, Mendoza, Santiago, and Tucumán are most important. The processing of local raw materials dominates manufacturing. The industries include sugar refining, dairying, flour milling, meat-packing, and food canning. Other industries are developing. Córdoba is the leading motor vehicle

center in Argentina. Textiles, machinery and cement are also produced.

Principal manufactures. Argentina has well-developed consumer and capital goods industries. Over one million persons are employed in manufacturing that provides over 20 per cent of the gross national product. Food, including beverages, is the leading industry of the nation, measured by number of employees, value of product, and value added by manufacture. This industry is followed by textiles, metals, machinery and motor vehicles, and chemicals.

Argentina's textile industry is able to satisfy the country's needs in all respects, with the exception of specialty yarns and some synthetics. In the cotton sector of the industry there are some 70 spinning mills operating nearly a million spindles and consuming annually over 100,000 tons of raw cotton. The cotton textile industry employs about 80,000 workers. The woolen industry is smaller, having 350,000 spindles and 9,000 looms. The synthetic industry has been making rapid strides and now produces over 12,000 tons of acetate yarn and monofilaments annually.

Although Argentina consumes between 1,000,000, and 1,500,000 tons of iron and steel annually, this primary industry is poorly developed. The steel capacity is rated at about 250,000 tons a year in open-hearth and electric furnaces using domestic and imported scrap and imported pig iron. The steel rolling mill capacity is about 70,000 tons; this is sufficient to roll most of the requirements of the commonly used products. There is also some production of pipe and tubes, galvanized iron sheets, barbed wire, springs, and similar items. Foundries are well equipped and produce about 140,000 tons of castings annually. In order to reduce the country's dependence on imported iron and steel a completely integrated steel plant has been built at San Nicolás. Its first production was in 1961. It is jointly owned by the government and by private capital. The plant includes blast furnaces, coke ovens, open-hearths, and mills to produce blooms and billets, strips and structural shapes, hot and cold rolled sheets, and tinplate.

The machinery industry of Argentina is well established, producing a wide variety of products, including machine tools. The machine tool industry has a relatively long history in the nation. Prior to 1930 simple lathes, milling machines, and drills were produced. The early manufacturing usually occurred in large workshops which specialized in castings and the repair of machine parts. During the 1930's, when imports were restricted because of depressed economic conditions and again in World War II when imports were limited, the domestic industry expanded to meet local demands. There are now about 175 machine tool establishments in Argentina employing about 5,000 skilled workers. Buenos Aires is the leading center. Other centers include Rosario and Córdoba. About 75 per cent of the plants produce only machine tools. Most of the factories make medium and large semi-automatic machine tools. However, output does not satisfy domestic demand, especially in the high speed, automatic-controlled machine tools.

The manufacture of industrial machinery and equipment began with simple repairs. In a number of branches it has reached an advanced level. At present there are more than 240 factories producing agricultural machinery. Some of these plants are on a large scale, with more than 6,000 workers, and produce other types of machinery and consumer durables. The industry is highly concentrated in the Buenos Aires area, and in the provinces of Córdoba and Santa Fe. All types of agricultural machinery are produced, and only raw materials and some bearings are imported. Other types of machinery include hydraulic presses, mining machinery, distillation machines, and machines used by industries making foodstuffs, dairy products, beverages, pulp and paper, oils, and chemicals. Textile machinery is also an important branch of production.

The electrical equipment industry is fairly well established, producing transformers and diesel and electrical generators. The production of electric motors is strongly protected by import tariffs. A wide range of electrical household appliances, such as radio and television sets, are manufactured. The nation is essentially self-sufficient in these products.

The assembly of motor vehicles from imported parts was one of the early engineering

industries in Argentina. In the 1930's the manufacture of domestic vehicles began. This industry was discontinued during World War II when it was found to be more profitable to manufacture small arms for export. After World War II the mass production of light delivery vans and jeeps was begun as an adjunct to a military plant producing aircraft equipment in Córdoba. Early in 1956, a second plant, also in Córdoba, began the mass production of light trucks and motors. The manufacture of passenger cars began in 1958. The industry has been localized primarily by the availability of skilled labor associated with the defense industries of Córdoba. The demand for domestically produced motor vehicles is high in Argentina as a result of stringent import restrictions which were imposed for many years.

Argentina has the best developed shipbuilding industry in Latin America. There are 270 shipyards employing more than 10,000 workers. However, about 80 per cent of the activity consists of maintenance and repair. Most of the shipyards are small. The government controls one shipyard which has facilities for building ships of up to 10,000 gross tons in size. There is also a privately owned shipyard with a capacity for ships up to 5,000 gross tons. The shipbuilding industry requires for its full operation a number of auxiliary activities, such as a steel industry and the manufacture of engines. The metal industry is sufficiently advanced to supply the required steel. Some marine equipment is produced domestically, but the limited development of propelling equipment is a serious obstacle. One factory produces diesel engines of medium power, but its output is primarily absorbed by the locomotive industry.

The chemical industry has experienced considerable growth in recent years. Employment in the industry totals more than 22,000. A wide variety of chemical products are produced such as benzene, ammonia, nitric acid, sulphuric acid, caustic soda, aniline dyes, phenol, calcium chloride, lithopone, and hydrochloric acid. The pharmaceutical sector of the industry has over 400 plants. A number of American pharmaceutical firms produce such specialties as insulin, cortisone, streptomycin, and a wide range of antibiotics. The plastics industry has shown steady advancement. Principal products are phenolic molding powders and resins.

A wide range of other products is produced. Argentina is nearly self-sufficient in leather goods. In addition to sole leather, local tanners produce the bulk of the demand for upper, patent, upholstery, and fancy leathers. Argentina's shoe industry is one of the best developed in Latin America. Although Argentina produces a full line of rubber goods, the production of tires and tubes for motor vehicles dominates. Portland cement is Argentina's leading building material, and this industry has an annual capacity of about 2,900,000 tons. In recent years the production of bicycles, scooters, and motorcycles has received government aid.

Chile

Manufacturing has become a major economic activity in the Chilean economy. The nation ranks among the most highly industrialized countries in Latin America. About 20 per cent of the working population is engaged in manufacturing and this industry provides nearly 20 per cent of the total national income. Chile's industry was small until the World War I period. Prior to this time the nation depended primarily upon imported manufactured goods to supply the domestic market. Because of war conditions manufactured goods from foreign sources were no longer available. The nation was forced to supply a greater proportion of its own basic needs. A considerable portion of the initial investment in industry came from foreign sources, principally the United States. Gradually, Chilean capital became available for a greater share in industrial investment. In the Concepción and Valdivia areas, Chileans of German extraction control a large share of the manufacturing. The Chilean government has encouraged industrial growth through exemption from certain taxes and from import duties on raw materials and equipment, restrictions on the exporting of raw materials, bilateral trade agreements, and protection against imports of manufactured goods by means of custom duties and quota licensing as well as exchange restrictions.

The postwar industrial expansion proceeded rapidly until about 1955. Since then the growth of the Chilean economy has been retarded. Chile has been plagued by serious inflationary problems. As a consequence investment in industry has lagged. At the same time the buying power of the population has been lowered. The industries producing capital goods or durable consumer goods have experienced greater declines than those producing consumer goods. This indicates that the elasticity of demand in basic consumer goods, such as foods, is much less than for capital goods. The inhibiting trends of manufacturing in Chile are in contrast to most Latin American nations.

Location of industry. Chile's manufacturing is chiefly concentrated in the central portion of the country. About 55 per cent is located in the province of Santiago, 20 per cent in Valparaiso, and 10 per cent in Concepción. The industry outside the central region is primarily devoted to the processing of minerals, such as the production of nitrate at Antofagasta or the smelting and refining of copper at Chuquicamata and Potrerillos in northern Chile.

The growth of manufacturing in Chile is reflected in the rise of the industrial city. At present these cities offer the greatest economic opportunities. An industrial middle class is rapidly increasing in the cities, providing workers for the expanding labor market.

Industries. Chilean industry produces a variety of products, most of which are marketed domestically. The consumer goods industries were established first and are still the most important. Chile now produces most of its domestic requirements in textiles, window glass, pottery, chinaware, furniture, rubber goods, radios, and many food products such as flour, sugar, and beverages. Chile furnishes a large part of its own pulp and paper needs and exports a small quantity of newsprint to Bolivia, Argentina, and Peru. There is a growing output of pharmaceuticals, plastic products, paints, and leather goods.

Of the consumer goods, the textile industries are among the best developed. The textile industry is about equally divided between woolens and cottons, although the synthetic fibers industry has been growing in recent years. Raw cotton for the textile industry must be imported, but wool is largely supplied from domestic sources. Chile, with about 125 textile mills, has one of the most modern textile industries in the Western Hemisphere. This industry is centered around Santiago, with important branches to the south in Concepción, Tomé and nearby Viña del Mar. The cotton textile industry possesses over 200,000 ring spindles and produces about 16,000 tons of cotton yarn annually. In order to encourage the textile industry a school has been established in Concepción to provide specialized textile education.

The Chilean cement industry is one of the oldest in Latin America. The first plant was completed in 1908 at La Calera between Santiago and Valparaiso. During World War II a second plant was built near Coquimbo. This plant was constructed with reconditioned machinery from the United States. Because of the growing construction of buildings, railroads, and public works, cement consumption has soared. Annual output is now about 750,000 metric tons.

In order to encourage the expansion of capital goods industries, an iron and steel industry has been developed. In 1947, with capital and technical aid from the United States, a small but modern iron and steel industry was built at Huachipato, an industrial suburb of Concepción. Chile possesses the basic raw materials for this industry. A large reserve of high quality iron ore is located at El Tofo, and the ore is brought directly to the steel plant by water transportation. Limited reserves of lignite and subbituminous coal are found in northern Chile on the Lebu Peninsula. Some coking coal must be imported to supply the blast furnaces. Limestone is obtained from an island off the coast of southern Chile about 900 miles to the south. The plant's pig iron capacity is 205,000 metric tons per year and the steel capacity about 235,000 tons per year. This is about one-fifth the capacity of Brazil's plant at Volta Redonda. Nevertheless, it is sufficient to supply Chile's domestic demands.

As a response to the availability of iron and steel, the metal fabricating industries have expanded rapidly. A small machinery industry now produces such items as agricultural

and industrial machines. The manufacture of electric motors began in 1948 and has developed due to a steady demand. Production has been concentrated on motors of less than one horsepower. The electrical household appliance industry has been expanded in recent years, and the country annually produces about 10,000 refrigerators, 11,000 washing machines, and 9,000 floor polishers. One major plant in Santiago manufactures copper wire, cables, and tubing.

The increasing diversification of Chile's manufacturing is illustrated by the small but expanding chemical industry. The nation possesses large quantities of chemical raw materials such as sulphur, borax, coal, and sodium nitrate as well as sulphides from metallic ores. The fertilizer industry is well developed, and Chile is the world's greatest supplier of iodine, a by-product of the nitrate industry. The manufacture of explosives has developed to supply Chile's mining industry. Coal tar and coal tar products are being produced as by-products by gas companies in Santiago, Valparaiso, and Antofagasta.

Colombia

Colombia has made considerable advances in manufacturing in recent years. Between 1953 and 1961, manufactural output, measured by value of production, rose by about two-thirds. Governmental policies have encouraged the growth of manufacturing. Because the nation is nearly self-sufficient in many consumer products, such as beverages, foods, and textiles, the government has placed a high import duty on these items. In contrast the nation is still greatly deficient in most capital goods, and the imports of these products continue to increase. Imports of raw materials are also of importance in the expanding industrial development. This trade policy is facilitated by the low exchange rate for materials and equipment as compared with that of manufactured capital goods. The high rate of investment in industry by private citizens has also been an important inducement. Information pertinent to the establishment of new plants is provided by such governmental agencies as the Institute of Industrial Development.

Location of industry. Industrial regions have not yet evolved in Colombia. Bogotá, Medellin, and Cali in the highlands are the leading industrial centers. Other important industrial towns in the highlands include Bucaramanga, Manizales, and Pereira. The newest industrial area is developing at the iron and steel center of Paz del Rio in the Department of Boyaca about 155 miles northeast of Bogotá. On the northern coast, Barranquilla and Cartagena have developed manufacturing. These northern coastal cities are well situated to receive imports of raw material and capital goods.

Structure of the industry. The consumer goods industries dominate Colombian manufacturing. Beverages, foodstuffs, tobacco, textiles, shoes, and apparel account for about two-thirds of the total value added by manufacture. Beverage manufacturing is the leading industry of the nation, followed by textiles. Brewing, a monopoly granted to departmental governments, is the principal branch of the beverage industry and is widely dispersed.

The textile industry, as a modern factory industry, is relatively new, with most developments coming since 1920. Some of the largest and most up-to-date cotton mills on the continent are found in the highlands of Colombia. About 300,000 spindles and 7,000 looms compose the cotton textile industry. Three firms produce about 75 per cent of the total annual output of more than 200 million yards of cotton fabrics. The woolen and synthetic fiber industries are of little importance. The textile industry is largely localized in the Department of Antioquia. Medellin is sometimes known as the "Manchester of the Andes." Other important textile centers include Bogotá, Manizales, and Cali. Originally, most of the raw cotton had to be imported, but because of a domestic program Colombia is now essentially self-sufficient in its cotton requirements. Textile machinery is a major import.

The apparel and footwear industries have increased their importance in the industrial picture. The 21,000 establishments producing these products are mostly small, individual enterprises of an essentially artisan character. In order to supply the demand for leather, the tanning industry has been enlarged and

now consumes most of the domestic supply of hides. About 50 widely dispersed tanneries process the nation's hides. In recent years mechanized shoe factories and ready-to-wear clothing establishments have been increasing in importance.

The chemical industry has grown rapidly since 1940. Of the products produced, pharmaceuticals and toilet articles are the most important. In recent years the industry has been diversifying its products. An alkali plant adjacent to the salt mines at Zipaquirá supplies the domestic market for soda ash and most of the caustic soda. Sulphuric acid is produced from sulphur partly imported and partly supplied from mines near Popayán. By-products from the coke ovens of the Paz del Rio iron and steel plant and the Barrancabermeja oil refinery are used to produce fertilizer. Other chemical products include paint and insecticides.

The metal and machinery industries are in an early stage of development. The first iron and steel plant began operation in 1954 at Paz del Rio. This plant is oriented to the iron ore deposits of the area. Coal deposits are within 60 miles of the furnaces, and limestone is quarried locally. Nevertheless, the raw material base of the industry is not entirely satisfactory. The iron ore has a high proportion of "fines" (fine particles that clog the blast furnaces), requiring that about one-half of the ore mined be discarded. The ore which is used is of a low iron content and unstable quality. As a result the blast furnaces must be cleaned frequently, thus raising costs. A sintering plant is needed in order to improve the quality of the ore. The coal is also of poor quality. Despite these problems the industry is expanding. The mill has a 138,000-ton-per-year blast furnace capacity, a 200,000 ton-steel capacity (composed of three Bessemer furnaces and one steel furnace), a combination bar and roll mill, and a wire mill. The coke plant has a battery of 43 ovens and is equipped with a by-product unit. The plant is connected by the National Railroad with Bogotá and other centers and by highways to the south and west.

As a result of the availability of iron and steel, a number of small metal consuming industries are being created. Among the leading establishments are the machine shops producing such items as brown sugar refining equipment and coffee depulping machines. There has also been a rapid rise in industries producing appliances. A number of foreign companies have established branch plants. For example, the General Electric plant in Bogotá initially produced refrigerators and air conditioners, but has diversified its production to include radios, television sets, washing machines, electric ranges, and electric light bulbs. Many of the more intricate parts for the electrical appliances are imported and assembled in Colombia.

A number of other industries deserve mention. The cement industry of Colombia is well developed, with eight plants in operation. There is abundant raw material and a local market. Although there is considerable handicraft glass production, modern plants in such centers as Zipaquirá and Barranquilla produce plate and window glass, as well as such specialty products as glass for light bulbs. A new aluminum rolling mill has been built at Barranquilla for production of aluminum foil. A paper industry has been initiated which produces kraft wrapping paper, white bond paper, and paperboard for boxes. The large mill located at Cali uses sugar cane bagasse as one of its raw materials. Colombian artisans are noted for their production of pottery as well as fine porcelain china.

Mexico

The increase and the diversification of the country's basic manufacturing have constituted the most salient characteristic of industrial development in recent years. There are now over 1,300,000 employed in manufacturing enterprises. The over-all volume of manufactured goods has increased almost steadily in the past two decades. In a number of industries, such as cement, textiles, and shoes, Mexico has achieved a stage of self-sufficiency. Prior to 1945 consumer goods industries were dominant. In recent years the production of capital goods has become increasingly important. For example, between 1945 and 1960 capital goods production rose by more than 66 per cent, while consumer goods had an increment of 10 per cent.

The expansion of industry has been a response to a number of related factors. The growth of manufacturing has been possible, in part, by rising wage levels in Mexico. This has resulted in an expanded demand for manufactured articles. There has been an intensive investment program in the manufacturing industries. This has given rise to the establishment of new industries of considerable importance and a rapid expansion of basic industries. In effect it has led to the substitution of domestic production for goods originally supplied by imports. The development of such basic industries as iron and steel permitted the establishment of numerous iron and steel fabricating industries. New plants for the manufacture of transportation equipment, electrical appliances, and machinery can now rely on domestic raw materials. In order to expedite this process it has been necessary to solve serious problems concerning labor supply, transportation facilities, availability of power, and others.

The Mexican government has encouraged the growth of industry, particularly the manufacture of capital goods. This is accomplished through the protection of domestic industries by raising import duties, by requiring import permits on competitive foreign products, by granting tax concessions, particularly on new industries, and by granting financial aid through governmental banks and other credit institutions. The Fund to Guarantee and Develop Medium and Small Industries was established in 1954 and has been expanded. For the most part, industry in Mexico is controlled by private companies. However, some industrial establishments are partly owned and controlled by the government. Direct foreign investment in manufacturing has grown from about $4,600,000 in 1940 to over $420,000,000 in 1960.

Manufacturing regions. Two distinct manufacturing districts have developed on the Mexican Plateau. The first, and largest, is found at the southern end of the plateau, extending from Guadalajara to Córdoba and centering on Mexico City. About 40 per cent of Mexico's industrial production is situated in the Federal District and the adjacent areas. This area rivals São Paulo for leadership in the manufactural regions of Latin America. Guadalajara is Mexico's third ranking industrial city. Prior to World War II this large region was noted for its textiles and food processing. Since 1945 there has not only been a rapid expansion in output but a diversification of products produced. The large population with a considerable purchasing power has created a demand for such factory produced items as flour, leather goods, radios, glass, motor vehicles, tires, gasoline, metal fabricated goods, paper, and cement. Although this area lacks coal and petroleum resources, the availability of hydroelectricity from the surrounding mountains provides a needed source of power for the manufacturing industries.

In the northern portion of the plateau an industrial complex has developed centering on the cities of Monterrey, Monclova, and Saltillo. Monterrey is the second largest manufacturing city in Mexico. This is the major iron and steel region of Mexico, with about 70 per cent of the nation's capacity located in Monterrey and Monclova. In recent years steel consuming industries have developed in the region. Besides the expanding metal fabrication industries, other factories have developed which produce tile and glass, furniture, liquors, cigarettes, and many other products. A small steel center in northern Mexico is located at Eagle Pass just across the border from the United States. This plant produces about 18 per cent of Mexico's steel using imported scrap and natural gas from the United States.

Other lesser industrial centers are located in the states of Veracruz, Coahuila, Hidalgo, Guanajuato, San Luis Potosí, and Yucatan. All of the larger cities and state capitals have some manufacturing. In general, there is a gradual decentralization of industry. An increasing number of new establishments, such as pulp and paper, petroleum refineries, chemicals, metallurgical plants, and sugar, wheat and flour mills are located in new centers of manufacturing. These plants are oriented to local sources of raw materials and power, and growing regional markets.

Types of industries. Although consumer goods industries have been declining relatively in relation to growth in the capital goods industries, they are still most important

from the standpoint of employment and value of production. Of the consumer goods, textiles, particularly cottons, occupy a prominent position. The textile industry is possibly the oldest of Mexico's modern industries. The mechanized textile industry began in Puebla, and that city was for a long time considered Mexico's textile center. Orizaba was also an early textile center, possessing some large mills. Since World War II the textile industry has increased considerably in the Federal District of Mexico City as well as in Guadalajara. The cotton textile industry now possesses about 1,175,000 spindles and nearly 40,000 looms. It is market oriented. Most of the cotton consumed by the textile industry is produced in the areas of central and northern Mexico.

Traditionally cotton dominated the textile industry of Mexico and is still of greatest importance. A number of small and medium-sized woolen and worsted mills have developed. The output of synthetic fibers increased from about 4,000 metric tons in 1948 to over 13,000 metric tons in 1960. In the synthetic fiber sector of the industry there are a large number of small manufacturers processing both locally produced and imported yarns.

Mexico has one of the largest iron and steel industries in Latin America. The manufacture of iron and steel began in Monterrey in 1903. A second major center at Monclova appeared in 1944. The location of the iron and steel industry in Monterrey and Monclova reflects their strategic position in regard to the assembly of raw materials and the marketing of iron and steel to the south in such cities as Mexico City, Guadalajara, and Puebla (7). These plants use coking coal from Sabinas to the north, iron ore from Durango, limestone from local sources, and manganese from northwestern Chihuahua. Both plants use water from local rivers. The Sabinas coal deposit, although limited in reserves, is one of the best coking coals in Latin America. The Durango ore is of high quality and mined by open-pit methods. This part of Mexico is one of the few sections of Latin America where the raw materials for the iron and steel industry can be assembled at low cost, and where transportation to market is available. Steel production in Mexico has risen from 290,000 tons in 1948 to over one million tons in recent years.

The chemical industries of Mexico have been experiencing a remarkable period of expansion. Of the products, heavy chemicals have shown the greatest growth. For example, the output of sulphuric acid increased from 56,000 metric tons in 1951 to over 200,000 metric tons in 1960. There has also been a significant rise in such chemicals as ammonium sulphate, caustic soda, and superphosphates. A major objective of Mexico's chemical industry is to make the nation's agriculture less dependent upon imported chemical fertilizers. There is also a greater demand for chemicals as other industries such as bleaches for paper and dyes for textiles are developed.

A number of additional industries have become important. Metal fabricating has experienced considerable growth. The assembly of motor vehicles began in Mexico in 1954, and annual output now exceeds 40,000 units. Cement production has increased from 830,000 metric tons in 1948 to over 2,500,000 metric tons today. A machinery industry is in the process of developing. The yearly output of electric motors has increased from about 2,300 in 1950 to over 41,000 today. The output of radios has grown from 16,000 in 1950 to 275,000 annually, and television sets from 1,600 to 80,000. In the production of shoes annual output is about two million pairs. As a response to growth patterns, Mexican industry is undergoing changes associated with maturing industrialization. Manufacturers are not only broadening their range of products, but are also producing more complex products. As the competition among manufacturers increases the quality of the manufactured products is being raised.

AFRICA

Although the traditional handicraft industries of Africa date from antiquity, modern factory industrialization is still in its initial stages of development. Traditional handicrafts exemplify the best of African technical skill, and although they are practiced in all parts of Africa, specialized production destined for a commercial market is only well organized in North Africa. South of the Sahara the

traditional handicrafts are often primitive and associated with agriculture.

The importance of manufacturing varies greatly from country to country (22). The Union of South Africa is the only nation that has reached an advanced stage producing complex manufactured products, such as machinery. The Federation of Rhodesia and Nyasaland, Egypt, Algeria, and Morocco represent an intermediate position between the Union of South Africa and the underdeveloped nations of the continent. The intermediate industrial nations produce a fairly large variety of products including nondurable consumer commodities such as textiles, foods, rubber goods, paper, building materials, and chemicals, particularly fertilizers; but only the simplest machinery is produced in these countries. For example, in the period 1955 to 1960 the contributions to value added in manufacturing from the groups comprising machinery, transport equipment, and other metal products was but 7 per cent in Egypt, 8 per cent in the Federation of Rhodesia and Nyasaland, and 16 per cent in Morocco. In these areas the most important activities in the metal industry are repair work and the auxiliary business of furnishing spare parts.

In the least developed industrial countries manufacturing is characterized by small-scale production, the predominance of consumer nondurable industries such as food and textiles, a small number of modern factories, and the relative simplicity of the manufacturing process. In general, the value added in manufacturing is least in the underdeveloped nations and most in the advanced nations. For example, in Kenya and Tunisia the value added in relation to gross value is 22 per cent and 28 per cent respectively, while in the Union of South Africa the value added is 43 per cent.

The type of manufacturing varies greatly from country to country. In Egypt textiles predominate, accounting for more than half of the value added. In Algeria and Morocco, food, beverages and tobacco are of greatest importance, while in the Congo and the Federation of Rhodesia and Nyasaland, base metal industries contribute nearly two-thirds of the value added.

Problems of industrialization. Many problems have hindered the growth of an industrial economy in the African countries. Most of the colonial powers in Africa viewed the continent as a supplier of primary raw materials and a market area for manufactured products. This is reflected in the emphasis placed on export products such as cotton, minerals, and palm oils. As the nations become independent the colonial character of the economy changes rapidly.

In the majority of African countries manufacturing has been established mainly with non-African capital, entrepreneurship, and skill. The African population has been involved in manufacturing chiefly as a source of unskilled or semiskilled labor. In recent years this problem of outside development has been partially solved. Native enterprise has developed significantly in North Africa, notably in Egypt, where factories have been built by nationals.

Although Africa is a producer of raw materials, all African countries must rely to a varying degree on imports of raw materials for manufacturing. This is primarily due to the specialization in production by the individual countries. Although in certain instances deficiencies at the individual country level are met by interregional trade, most industrial raw materials are derived from outside the continent. Sometimes the imports originally come from Africa, and are partially processed outside the continent before being returned for final manufacturing.

A number of other problems have slowed manufactural growth. The lack of a well-developed transportation system has hindered development. In many areas high transportation costs result in prohibitive manufacturing costs. The low buying power of the continent's native population has limited the market potential. In a number of sections the white population is too small to provide an adequate labor force, and there has been a reluctance to educate the large colored labor force in order to make it effective in the growth of industry. This applies particularly to the Union of South Africa.

Location of industry. A locational feature which is common to all countries, irrespective of the stage of development, is the heavy

concentration of industrial establishments in one or a few urban centers. In Egypt, the cities of Cairo and Alexandria possess nearly two-thirds of the manufacturing establishments, providing for half the nation's industrial employment and value added in manufacturing. In Morocco about 70 per cent of the industrial establishments are located in the Casablanca metropolitan area, canning and preserving being the only industries located along the sea coast and oriented to a supply of raw materials. In the Federation of Rhodesia and Nyasaland manufacturing is concentrated along an industrial axis formed by Salisbury and Bulawayo. In the Republic of the Congo, manufacturing is centered in Leopoldville, Elisabethville, and Jadotville.

The Union of South Africa is Africa's major manufactural nation. Manufacturing is concentrated in the Southern Transvaal, centering in the cities of Pretoria, Johannesburg, and Vereeniging and in the three coastal nodes, Cape Town, Port Elizabeth, and Durban. The Southern Transvaal is the leading industrial region in the Union of South Africa, possessing nearly one-third of the operating plants and producing about 40 per cent of the gross value of manufactured products.

Union of South Africa

The origin of modern industry in the Union of South Africa dates from the beginning of gold and diamond mining in the 1870's. Initially, manufactured goods were imported to sustain the mining economy. Gradually assembly plants processing semimanufactured goods developed in the port cities in order to supply finished articles at a lower cost than imported goods. The port cities were then the early centers of manufacturing.

Manufacturing did not grow rapidly, and at the time of World War I the Union was still largely dependent on imported articles. However, at this time the import of manufactured goods largely stopped. By the elimination of overseas supplies, the First World War created a stimulus for greater manufactural activity within the Union. Another impetus to increased manufacturing came in 1932 when the purchasing power of gold increased. This resulted in a large inward migration of capital, which was primarily invested in manufacturing.

It has been only since the Second World War, however, that manufacturing has become an important part of the nation's economy. The position of manufacturing in the economy rose from eighth place in 1914 to first place by 1949. In 1930 the country produced less than eight per cent of its needs in steel; in 1951 it produced nearly two-thirds of its needs. Remarkable progress has also been made in the production of electricity, which increased from 7.5 million kilowatts in 1946 to over 19 million in 1960. Large-scale development of the textile industry began only after World War II. The first integrated cotton spinning and weaving mill came into operation in 1947. The Union now supplies a fourth of its cotton goods and three-fourths of the wool goods that are consumed there annually.

The industrial development of the Union has resulted in a highly diversified manufacturing economy. Emphasis has been placed on the expansion of the metal industries. As a result many companies with home offices in Britain and the Netherlands as well as in the United States, Canada, Sweden, and France have built branch plants in the Union. For example, the only plant producing copper tubing in the Southern Hemisphere has been built by British engineers. Although the ties with foreign companies are increasing in importance, local capital is also being invested in the new manufacturing enterprises.

One of the greatest problems to industrial growth is the shortage of labor. At the present time the manufactural industries are unable to utilize an estimated three-fourths of its worker potential. The colored population is, in general, not a major source of trained, skilled labor. The white population is too small to provide large numbers of workers. The labor shortage in the immediate future can be relieved only through immigration by the thousands from European countries.

Southern Transvaal. A modern industrial complex has developed in the Southern Transvaal. The area contains many specially planned industrial townships with all the

necessary services and amenities.[1] The growth of manufacturing in this area has been fostered by a number of factors. First, this area lies close to the gold and diamond region of South Africa so that a local market has been provided for many manufactured articles. Second, the region contains a considerable number of industrial raw materials, particularly iron ore and coal. Third, the area is well served by transportation facilities. Fourth, major hydroelectric power facilities are developed at a number of sites within the area and power is secured from additional nearby sources. Also, as the result of vast quantities of low-grade coal, thermal electric power stations have been built in the region, with the largest at Vierfontein.

The growth of manufacturing in the Southern Transvaal has also been aided by special railway transportation regulations. In 1909, Section 127 of the South African Act stated that the railway system should give due consideration to the development of agriculture and industry within the nation and the promotion by means of cheap transport of agriculture and industry to the inland portions of all provinces (21). In order to implement this policy, the railway administration developed a freight rate system whereby there were low tariffs for the transport of raw materials and high tariffs placed on finished goods. This encouraged the growth of industry near the large centers of population where the short hauls made distribution costs for the finished products small. Since the Southern Transvaal was the largest population center of the Union, industrial development was encouraged by this discriminatory freight rate policy.

Another factor favoring interior industrial growth has been the tapering rate structure of transportation. Under this policy the cost per mile decreases with increasing distance from points of origin. As a result of this rate structure, low-value, high-bulk commodities can be transported greater distances. This decreases the importance of raw material orientation and increases the drawing power of the markets. For example, iron ore is carried at the rate of 31 shillings and 8 pence per ton for a 50-mile haul, but the charges are only 19 shillings and 2 pence for 1,000 miles (21).

One of the earliest industries established in this area was that of iron and steel. Two small blast furnaces, one at Pretoria, the other at Vereeniging, produced between 15,000 and 20,000 tons annually in the 1920's. As a result of increased demand the government in 1928 established a state-owned company—the South African Iron and Steel Industrial Corporation —for the manufacture of iron and steel at Pretoria. The first steel was tapped in 1934 and the new plant had an initial capacity of 180,000 ingot tons per year. The plant has been enlarged several times and in 1961 had a capacity of 1,100,000 ingot tons per year. The selection of Pretoria as the site of the first integrated iron and steel plant in South Africa was a response to a number of factors. The presence of the Timeball Hill iron ores within the Pretoria town limits and the municipality's refusal to allow the ores to be mined unless they were smelted locally was of major consideration. It was also believed that a large percentage of the iron and steel production would be consumed locally by the South African Railways since Pretoria was the principal distributing center. This assumption proved incorrect, for less than 10 per cent of the iron and steel produced is consumed by the railroad. Nevertheless, the engineering industries of the region have provided a large local market.

As the market for iron and steel increased a second iron and steel center was built at Vanderbijl Park, about 11 miles west of Vereeniging, in 1952. The plant was built on the open veld and a new town created which now has a population of over 50,000. Through rapid development, the iron and steel plant had a capacity of 1,250,000 ingot tons in 1961 making it the largest in the Union of South Africa. The rapid expansion of this plant is attributed not only to the growing market but to the vast coal deposits in the vicinity and abundant water from the Vaal River.

At the present time iron ore for both Pretoria and Vanderbijl Park is obtained from

[1] The following larger municipalities contain at least one industrial township within their boundaries: Johannesburg, Springs, Vereeniging, Vanderbijl Park, Alberton, Edenvale, Nigel, Benoni, Germiston, Krugersdorp, Randfontein, Roodepoort-Maraisburg, Pretoria, and Kempton Park.

Thabazimbi in northwest Transvaal, and, since 1950, from Sishen in northwestern Cape Province. The latter deposit has an estimated reserve of 400 million tons of iron ore with 60 per cent iron content. The coking coal for the Pretoria plant comes from the corporation's own coal mine at Dannhauser in Natal and is blended with coal from Witbank in the Transvaal.

The two centers of Pretoria and Vanderbijl Park produce about 90 per cent of the iron and steel of South Africa. A number of allied industries are associated with basic steel. In Vereeniging is located the largest steel foundry in the Union, with a capacity of 6,000 tons of steel castings a year. Ferroalloy plants produce ferromanganese, ferrochrome, and ferrosilicon in this region.

The Southern Transvaal is the principal region for production of engineering equipment. Approximately 100,000 workers are engaged in these industries. The engineering industries have reached a stage where practically every type of machinery can be made locally to overseas standards as long as the blueprints are supplied. Spectacular advances have been made in the manufacture of heavy machinery and equipment for mines and other industries. It is estimated the Union can now supply 80 per cent of her own heavy machinery needs. Electric motors, transformers, cables, telephone equipment, and domestic appliances are also produced in the region. For example, the first cable factory, established in Vereeniging in 1936, is now the largest factory of its kind in the Southern Hemisphere. After World War II five additional plants were established and the manufacture of cables has become a major industry.

The foundry industry has been greatly increased in recent years. Although a number of foundries were established in the nineteenth century, it was not until 1934 when the first coke was produced in Pretoria that this industry was freed from import of fuel. Now, nearly 200 foundries are found in the Southern Transvaal. Castings are made in nonferrous as well as ferrous metals. The range of local foundry products extends from tiny thumb screws to heavy mining and railway equipment.

The railway equipment industry has made considerable progress. The local production of rails, for which large amounts of foreign capital are needed, has been increased. The first railway freight cars were produced near the end of World War II. Because domestic demand has been satisfied, an export trade has developed with Rhodesia and East Africa. In 1959 the first factory was established at Nigel for the manufacture of passenger coaches. This same plant plans to produce diesel engines for the railway and for mining and industrial purposes. A second factory for the production of diesel engines is at Wadeville, Germiston. Small diesel locomotives specially designed for use in gold mines have been made for a number of years in Johannesburg.

A number of other industries have experienced considerable growth. The cement industry was one of the earliest industries in the region, with the first plant being built in 1892 at Hercules, Pretoria. About two-thirds of the output of South Africa is located in this area. The total output of South Africa has risen from 1,050,000 tons in 1945 to over three million tons in 1960. A recent development has been the production of cement from blast furnace slag.

The glass industry was established in the Southern Transvaal at Pretoria in 1937. A second center was developed in 1946 at Wadeville, Germiston. The Wadeville factory, which is the main factory and administrative center, produces a wide range of glassware for the Transvaal and other inland markets. The modernized Pretoria factory specializes in domestic ware and a recent addition is the production of opal glass.

The demands of the mining industry resulted in the early establishment of a chemical industry producing explosives. The first explosives factory was established at Modderfontein near Johannesburg in 1896. This factory is now the largest producer of explosives for peaceful purposes in the world. Prior to World War II explosives and some fertilizers were the principal chemicals. An expansion program has occurred and now about 50 different industrial chemicals are produced. The growth of the pharmaceutical industry is of considerable importance. All modern types of medicines are now produced

in the Union. Petroleum jelly (Vaseline) is made in Germiston. The full requirements of insulin are being met by a factory in Fordsburg, Johannesburg. The raw material is obtained from meat-packing establishments in the Union. Most of the adhesives used in the Union are produced at Pinetown. Antibiotics were made for the first time in 1959 at a new £250,000 plant opened at Isando, near Johannesburg.

Coastal nodes. The major port cities of the Union of South Africa developed as early centers of manufacturing. These industrial concentrations grew because of a number of factors. Since a large proportion of industrial raw materials is imported it was logical to process them at the port of entry. At the same time a large percentage of the agricultural and mineral wealth produced in South Africa was exported. These products, produced over a wide area, were collected in the port cities and manufacturing industries gradually developed.

A wide range of industries has arisen. Of these the textile and apparel industries are of significance. The woolen textile industries are among the oldest in the Union, having been established in the 1850's. The traditional center of the industry is the Port Elizabeth-Uitenhage area. Factories are now located at Durban and East London and a development has begun in the Cape Town District. Originally the industry concentrated on the production of woolen goods, particularly blankets, but it now produces worsted fabrics as well. Because the industry chiefly uses cheaper wools, approximately 60 per cent of the wool required has to be imported. Karakul wool constitutes about 25 per cent of the local wool consumed. The Union of South Africa is nearly self-sufficient in its wool textile requirements.

The cotton textile industry is of recent origin. The first integrated spinning and weaving mill came into operation in 1947. This group of industries now comprises about 30 establishments, producing about 50 million yards of goods annually. However, the national consumption is about 300 million yards. The industry has concentrated on producing low-quality goods—such as yarns, calicos, twills, and jeans—which can be produced by the low-skilled labor. The output of higher grade material demands a technical skill which nonwhite labor can only gradually acquire. Since South Africa produces a small amount of raw cotton, most of the cotton must be imported. In 1960 the cotton textile industry contributed about 25 per cent of the gross value of total textile production.

With the growth of the textile industry, the apparel industry has also expanded. The number of clothing factories has increased from approximately 250 prior to 1950 to 600 in 1960. The first apparel factories were developed in the southern Transvaal mining region to produce low-cost work clothes for the growing number of miners. These factories largely employed white labor. Later the industry migrated to the coastal cities where the wages of colored and Indian workers were lower. The industry is now of particular importance in the Durban District. The gross value of output has risen from approximately £1.3 million in 1939 to £69 million in 1959. The number of employees has increased during the same period from 4,100 to about 50,000, of which 35,000 are women. Colored and Indian women now form the largest racial groups among the employees while the percentage of white women is gradually decreasing. Of a raw material consumption of about £38 million annually, a little over £6 million is of local origin. The country has now attained a high degree of self-sufficiency in its apparel needs.

The footwear industry is also well established in the coastal centers. The traditional center is Port Elizabeth, but centers are now well developed in Natal. Because of ample supplies of hides and skins, tanneries were established during the nineteenth century. Although the hides and skins are mainly produced in the interior, the tanneries are located in or near ports, because the hides and skins were assembled at ports for export. The footwear industry has long been handicapped in its growth because of the condition of South African hides which, owing to the marks left by thorns, barbed wire, ticks, and the whips used by native herdsmen, are generally not suitable for the manufacture of "upper" leather (i.e., leather for the upper portion of the shoe). Most of the leather for the upper

portion of footwear is still imported. Nevertheless, the footwear industry has flourished, and the Union is nearly self-sufficient.

The port cities have developed many branches of metal fabrication and machinery production. Marine engineering is one of the oldest industries. Pleasure and fishing vessels are built at Durban. All-steel lighters are constructed at East London. The traditional center of wooden fishing-craft construction is Cape Town, where hundreds of vessels have been built to serve the local fishing industry. These vessels are usually 45 to 80 feet long and sturdily built to withstand the Cape storms. In 1956 the first South African steel shipyard was established in Cape Town. This yard is able to build and launch vessels more than 200 feet in length.

The automobile assembly industry has concentrated in the coastal cities of Durban, Port Elizabeth, and Cape Town. European and American motor vehicle manufacturers have established assembly plants in the coastal cities in order to supply the South African demand. Other engineering industries include the production of engines, machinery, and metal fabricated products.

A wide range of chemical and allied products are now produced in the coastal cities. The first plant was built at Somerset West, near Cape Town, in 1903. A second center developed at Umbogintwini, south of Durban, in 1909. This latter plant began as a producer of explosives, but production of these ceased after World War I, and the plant became a producer of fertilizers and industrial chemicals. At the present time the Somerset West and Umbogintwini plants are the major producers of phosphate fertilizers in the country, and the annual output from these two plants totals nearly 800,000 tons. The Umbogintwini plant also produces a variety of plastic raw materials. For example, polyvinyl chloride provides the coating for many types of synthetic leather cloth made at Somerset West. The chemical industry is expanding as illustrated by such new plants as the one in Mobeni, Natal opened in 1959 to produce polyvinyl acetates to be used in paint, textiles, and other industries. The petroleum refining industry has been greatly increased since 1950, with Durban being the largest center. In 1956 the Standard Vacuum Oil Refinery at Wentworth, Durban began the delivery of liquid petroleum gas by rail tank cars to industries in the interior.

Prior to World War II nearly all paper consumed in South Africa was imported. The lack of local forests to supply raw materials greatly retarded the growth of the industry. The early factories were established in the coastal cities of Port Elizabeth, Tugela, Felixton (north of Durban), and at Belleville (near Cape Town) in order to utilize imported pulp and pulpwood. The success of reforestation schemes stimulated interest in the manufacture of paper from locally produced pulp. The industry has expanded rapidly and new centers have been developed in the Southern Transvaal at Johannesburg, Germiston, Springs, and Benoni. In 1946 only about 5,000 tons of paper were produced. In 1960 the total productive capacity of the paper industry was about 250,000 tons, 80 per cent of which was utilized.

AUSTRALIA

Manufacturing has made notable progress in Australia since 1915. The two World Wars greatly stimulated the growth of manufacturing, since foreign imports were restricted. Although Australia is noted for its export of agricultural products, the high degree of urbanization is one of the country's outstanding characteristics. Sydney, with a population of 1,975,000, and Melbourne, with 1,677,000 have about one-third of the country's population. In other words, one out of every three Australians lives in the two largest cities. This concentration of population makes possible a high degree of industralization. A relatively small labor force is needed for the extensive forms of agriculture and grazing typical of an agricultural economy.

Structure of industry. One of three workers now depends upon manufacturing for a livelihood. Manufacturing in the early 1960's employed more than one million workers, as compared with 550,000 before World War II. During the same period the number of factories increased from 27,000 to 52,000. About 60 per cent of the 52,000 factories employ fewer than 10 persons. This group consists

mainly of small plants engaged in sewing and repairs. Of the total manufacturing work force, about one-half are employed in factories having more than 100 workers, and each of the 200 largest factories has a minimum of 500 workers.

Since World War II Australian manufacturing has undergone an unprecedented period of expansion. In recent years there has been a shift from consumer goods industries to heavy industries making products needed by an increasingly mechanized and complex economy. Industries producing heavy machinery, including electrical equipment, and transport equipment now provide for 33 per cent of all factory employment, compared with 25 per cent prior to 1940. The chemical industry and the fuel, lubricants, and power groups have expanded employment during the same period from 20,000 to 45,000.

Australia has now attained a position of self-sufficiency in many types of factory goods, and with some effort could become an exporter of manufactured products. The country's role as an important producer of raw materials and agricultural commodities remains important, but the economy is becoming more balanced as industry expands. Most of the Dominion's requirements for metal products, farm machinery (except tractors), communication equipment, furniture, and leather goods are provided locally, and Australia now produces two-thirds of the locomotives and rolling stock required, one-fourth of the wheel tractors used, and a large proportion of her requirements of electric motors, heavy power-generating equipment, drugs and chemicals, paper goods, and rubber products. The wide variety of goods produced is illustrated by such diverse factory items as plastics, radios, rayon acetate yarn, and penicillin. The growth of the motor vehicles industry is a striking example of the industrial advancement of the nation. Australia manufactures and assembles complete motor cars and produces more than one-half of the domestic demand.

There is considerable foreign investment in the manufacturing industries of Australia, particularly from the United States and the United Kingdom. Over 200 United States firms have investments in subsidiaries, and some 600 others have patent licensing and distribution facilities or other arrangements in Australia. The firms range from large to small enterprises. Almost without exception these investments have proved satisfactory.

Factors of industrialization. The rise of industry has been aided by a number of favorable factors. Australia produces a variety of agricultural and mineral products, providing the raw materials base for a number of industries. The rise of industry was also facilitated by there being only a single nation occupying the continent, thus insuring a unified internal market. Government policy has provided a protective tariff for industries considered strategic or of basic importance to the nation. The high Australian standard of living makes its concentrated groups of urban residents an attractive market for many types of manufactured articles. Within recent years steady progress has been made in technical skills with the help of overseas manufacturers, who have amalgamated with Australian firms rather than attempt to compete through the exchange of goods on the international market.

Manufacturing in Australia is still faced with a number of problems. Although the population is increasing, the shortage of skilled workers remains critical (32). The greater percentage of new settlers is expected to enter manufacturing. Industrial growth has also been handicapped by the poorly integrated railroad system. Because the individual states originally used varying gauges in building their rail lines, there was a break-of-bulk at or near state frontiers. This problem is gradually being solved by the introduction of a standard gauge throughout the Commonwealth. Movements of manufactured goods by freighter along the coast, with the exception of iron and steel, are much less significant than before. As a result of a small domestic market (9,600,000 persons) production costs remain relatively high. This is partly because of limited output. Low productivity is to some extent caused by labor problems. Australia continues to import from 20 to 25 per cent of the manufactured goods the country requires.

Manufacturing regions. Manufacturing has a marked concentration in the coastal cities, with the greatest development found in New South Wales and Victoria (27). The port cities

have been particularly attractive because of the state railways focused on them, and the large urban agglomerations provided not only a market but a labor pool. In the Hunter Valley, focusing on Newcastle, industry is directly related to the abundant and high quality coal resources (35). New industries are being encouraged to select locations in rural areas and in the less industrialized states.

Southeast Australia. Southeast Australia contains more than 80 per cent of the nation's manufacturing. A diversified industrial economy has evolved in this area, centering on Melbourne and Sydney. The metal industries and the complex of closely related industries are of outstanding importance. Almost two-fifths of the people are employed in the manufacture of machines and the production and assembly of vehicles of all kinds. The textile and clothing industries rank second, with half as many employees. Food processing, brewing, and related industries are third in importance. Of growing importance is a group of industries producing chemicals, dyes, plastics, explosives, fertilizers, paints, oils, and grease.

Southeast Australia contains the nation's primary iron and steel industry (33). Prior to 1915 Australia imported its needs in iron and steel. Since 1950 it has supplied all its domestic needs, and exports certain products from an annual output of about 2,250,000 tons of steel. The entire industry is operated by a single combine, the Broken Hill Proprietory Company. The first blast furnace was constructed during World War I in the Newcastle area. This site was chosen because of the availability of the abundant supply of coking coal. In 1928 a second iron and steel center was developed at Port Kembla in the southern coal field. The iron ore for both of these plants was obtained from the Eyre Peninsula. In 1941 a third iron and steel center was built at Whyalla, the port through which iron ore was shipped to east coast plants. A reciprocal movement of iron ore and coal has developed between the iron and steel centers on the east and south coasts.

Of these three centers, the Newcastle and the associated, industrialized Hunter Valley is the most significant. This area has over 70 collieries, producing well over half of Australia's coal output. The high-grade bituminous coal is not only the source of power, but is the raw material from which gas and coke are produced and upon which the heavy chemical industry of the region depends for its production of tar, naphtha, benzol, and sulphuric acid. This area has developed a thriving industrial complex. The wide variety of metal products produced includes galvanized iron sheets, tubes, castings, steel rope, fencing wire, nails, and axles. There are shipbuilding yards, and at Newcastle and Cardiff the state railway workshops make locomotives and rolling stock for the railways. A textile industry has developed in the area, and a large factory at Hexham has been built to manufacture rayon yarn. Sea transport has been a factor in the growth of industry in the area. The dredged port of Newcastle handles a greater tonnage of cargo than any other Australian port. Imports include iron ore from southern Australia, limestone from Tasmania, ferroalloys (nickel and chromium from New Caledonia, tungsten from King Island in Bass Strait), and phosphate rock from Nauru and Ocean islands. Of the exports, coal, coke, steel, fertilizers, and many other heavy and bulky manufactured items are shipped from Newcastle to other Australian ports and overseas.

The large capital cities of the Australian states—Brisbane, Sydney, Melbourne, and Adelaide—have developed a variety of consumer goods industries (29). These industrial centers have grown primarily in response to the available market and labor supply. Raw materials are light, usually only partly processed, and often imported. The tidewater location of the state capitals and the long-established road and railroad pattern focusing on the cities give them a significant advantage in the assembly of raw materials and the export of finished goods.

Of the industries present in these cities, textiles are among the oldest. Wool, cotton, and silk are spun, and a wide range of fabrics of both natural and synthetic fibers is woven. Clothing, knitgoods, hosiery, and leather products are produced in each of the capital cities, with a concentration in Melbourne and the neighboring areas of Geelong. The metal fabrication and engineering industries have also developed. Automobile assembly plants of American and British manufacturers have

been in operation in the principal cities, notably Adelaide and Melbourne, since about 1930. Originally, all parts were imported, but more recently there has been a steady trend to supply an increasing share of parts from domestic production. Other manufactured products include electrical equipment, agricultural implements, light chemicals and drugs, rubber goods, foods, and aircraft.

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GEOGRAPHICAL ANALYSIS OF SELECTED INDUSTRIES

PART TWO

CHAPTER SEVEN

IRON AND STEEL INDUSTRY

Steel is the wonder mineral of the modern age. Without it our present-day economy could not have evolved. It is the most common metal, and is used in every phase of our lives. In the home are steel stoves, refrigerators, washing machines, and a host of household gadgets. In modern industry the basic tools are of steel. In heavy construction, steel is a primary building material. It not only provides the skeleton framework that makes skyscrapers possible but it is also the metal used in factories, apartments, and, in recent years, for some home construction. Farm output has been relying more and more on steel implements to perform its functions, which range from plowing to processing the finished crops. Finally, the transportation equipment that makes possible the functioning of all of these modern economic activities consists largely of steel.

Because iron and steel are omnipresent in our modern industrial society, the state of the iron and steel industry is an important barometer of general business conditions. When steel output is high, it is recognized that the demand for steel is high because thousands of products are being manufactured in the nation's factories. This high production means that employment is at a high level and the buying power of the average citizen is great. When, on the other hand, steel output is low, the basic material for manufacturing eventually ebbs. Steel is the basic material for capital and consumer goods, neither of which is in high demand during periods of economic depression.

Why has steel gained such great dominance over other metals? Part of the answer lies in its unique qualities. No other metal has so many properties that are so valuable in the engineering and construction industries. Its strength, toughness, hardness, and malleability are outstanding compared to other metals. Steel can be alloyed easily with other metals, thus producing varying degrees of hardness and strength and giving it a wider range of application than any other metal. Finally, the magnetism in iron and steel permits their

use in mechanical equipment whose motion generates electrical current.

Besides having desirable properties, iron and steel are the cheapest of all metals. Low cost is a prerequisite if a metal is to be used in enormous tonnages. The low cost of these metals is largely a response to nature's bountifulness. No other metal has such vast deposits of easily mined high-grade ore. Until recently the iron and steel industry has avoided the problem characteristic of many other metal industries in utilizing low-grade ores. The higher grade iron ores in many of the older mining areas are now showing signs of depletion, and low grades are being processed. On the Lake Superior shore several large plants are in operation, beneficiating the low-grade taconite ores. Because these low-grade ores are utilized in huge quantities, the ore is still relatively cheap. Another factor which contributes to the low cost of iron and steel is the availability of enormous amounts of scrap. Steel production is on a larger scale than that of any other metal. A single steel plant of moderate size can produce annually many times the world output of any other metal. The availability of iron and steel is the key to the building of a modern industrial society.

EARLY LOCALIZATION

Archaeologists date the beginning of the Iron Age—when men smelted ore and used the metal to produce useful articles—from about 1400 to 1500 B.C. However, there is evidence that iron was worked in India as early as 2300 B.C. Wrought iron beams similar in size and appearance to those in modern buildings have been found in the ruins of Indian temples. In primitive forges the ancient metallurgists developed an excellent quality of wrought iron and steel. One of the earliest centers of iron and steel developed in the Hyderabad area of India, where the famous wootz steel was produced. This steel was of such high quality that it was marketed throughout the world. The reputation of Damascus and Toledo swords—which could be bent from hilt to tip and at the same time take a cutting edge never surpassed, even by modern techniques—was based on the strength and flexibility of wootz steel. For thousands of years the open wood or charcoal fires of the forges were the sole known method of smelting iron ore. Because iron ore and timber for charcoal were widely distributed, and the production of iron was small, the industry developed in widely separated regions. The Roman Empire had many iron producing centers in Italy, Spain, and Britain.

For more than 1,000 years during the Dark and early Middle Ages the technology and economic organization of the iron industry remained practically unchanged. Gradually the furnaces were improved and in the latter part of the thirteenth century the Catalan forges were developed. These forges were introduced into every ironmaking country. In these flat-bottomed forges, iron was made by the direct reduction of ore heated with charcoal. Initially the air to fan the fire was obtained by natural draft or by hand-operated bellows.

Because the temperature was rarely high enough for complete fusion of the metal, the iron produced by the Catalan furnaces was soft and malleable. On the other hand the metal produced at the relatively low temperature of the Catalan forges had absorbed little carbon, and the small scale of the operation permitted the iron masters to manipulate both the "bloom" of iron and the stream of air from the bellows, so that such carbon as was absorbed could be oxidized and eliminated. In this way a metal relatively free of carbon and other impurities, though containing a good quantity of slag, was produced. If however, the iron was heated for a long period, it would absorb carbon from the charcoal and harden, becoming brittle, breaking rather than bending. About 1350 the ironmakers of medieval Europe discovered how to cast iron. In this process, which was in common use by the beginning of the fifteenth century, the hot metal was run into sand molds with lateral channels. This product was called pig iron, since the molds resembled a sow with suckling pigs.

Smelting practices were improved during the fifteenth and sixteenth centuries, primarily by the Germans, French, and Belgians, and gradually the Catalan forge and its improved form, the German "stückofen" were both superseded by the charcoal blast furnace. The

charcoal furnace not only provided greater economy in fuel and labor, but also had a larger output. The iron was of a better quality, and its uses were greatly extended. As iron production increased, the overcutting of forest stands for charcoal became the major limiting factor of production. In general iron ore deposits were not exhausted in the countries of Western Europe, but timber resources did become scarce in many areas. The centers of the iron industry gradually localized in areas where charcoal could be made from vast forest reserves. As a consequence, Sweden with its abundant charcoal supplies became a leading iron center, producing some 30,000 tons of pig iron a year. The larger part of its output was exported to England. However, the iron industry continued to thrive in other nations. For example, in 1788-89 the Bureau de Commerce of France indicated that more than 600 charcoal furnaces were operating in the country. The small charcoal ironworks were relatively cheap to build and easy to operate. Furthermore, the finished metal was in universal demand, but its transport at this time made it desirable that the local market should be supplied from local furnaces and forges. The charcoal furnace had its greatest period of dominance in Europe during the latter part of the eighteenth century.

Long after charcoal became obsolete for smelting iron ore in the western European countries, it persisted as the major fuel in North America because of the vast forests. By the middle of the eighteenth century the British colonies were producing almost as great a quantity of pig iron as England, perhaps 25 to 35 per cent of the world output. After the American Revolution the iron industry in the United States did not expand rapidly and gradually lost its significant relative world position. In contrast to the great technological progress in Britain, iron continued to be smelted by charcoal in the United States until the introduction of anthracite in eastern Pennsylvania as the major smelting fuel in the 1830's.

The next phase in the localization of the iron and steel industry was intimately related to the Industrial Revolution, which was primarily a revolution in power and metallurgy. A series of inventions and improvements established the basis for the modern iron and steel industry. The great changes in the smelting of iron ore and shaping of iron were initiated in 1784 when the puddling furnace was developed in England. This furnace used coal (later coke) rather than charcoal for its fuel. The puddling furnace furnished hot malleable iron directly to the rolling mills in a single continuous process. It reduced the cost of manufacture and yielded a larger quantity and more uniform grade of iron. At essentially the same time a new rolling mill was evolving which could handle heavier blooms and greater lengths and could turn out a greater variety of shapes and sizes of rails, bars, and plates than had hitherto been possible. Formerly, a tilt hammer had difficulty processing a ton of bars in 12 hours, but now 15 tons of puddled metal could be passed through the rolls in the same amount of time. As a result of these changes in technology iron became cheaper and demands for its use grew rapidly. In order to produce iron in quantity the iron industry was drawn to the coal fields, where fuel was available. The use of coal in iron ore smelting freed England from its greatest iron industry handicap, a shortage of fuel. At the beginning of the eighteenth century, England was only one of many small iron producers; but the foundations were being laid for her assumption of world leadership in the next century. To hasten the development of her iron industry, England not only had abundant and readily accessible coal supplies but also a large number of mechanical inventions which could be applied directly to the iron industry and the expanding market of the British Empire (61).

MODERN PATTERN OF DISTRIBUTION

Under the influence of higher productivity, declining prices, and the expanding demands of iron in a dynamic industrial economy, Britain rapidly assumed world leadership. By 1788 Britain's 59 coke furnaces produced 53,800 tons of pig iron, as against 14,500 tons of charcoal iron made in 26 furnaces. The total output of pig iron in Britain increased from 68,300 tons in 1788 to 250,400 tons in 1806.

In the nineteenth century, production of iron grew rapidly (37). World output rose

from less than 400,000 tons in 1800 to 1,700,000 in 1820, 3,300,000 in 1840, and 7,400,000 tons in 1860. In 1820 Britain produced about 25 per cent of the world total but increased its share to more than half in 1860. The iron industry grew most rapidly in Britain during the first half of the nineteenth century. Gradually the modern industry developed in other countries. After 1840 iron manufacturing forged ahead in Germany as a result of the rapid growth of railroads and a series of inventions which greatly improved the quality of cast iron and made it in some respects superior to the British product. Output in the United States also began to increase, first under the stimulus of the anthracite furnaces in eastern Pennsylvania in the 1840-1860 period, followed by the use of coke blast furnaces in western Pennsylvania. In 1870 Great Britain was still the world's leading producer, with an output of 5,964,000 tons of pig iron, while the American output was 1,665,000 tons and that of Germany, 1,240,000 tons. These three nations produced about three-quarters of the world's iron output.

Within the next 40 years the position of the leaders changed. The United States experienced not only a termendous surge of new-plant building but had a spectacular program for increasing the output of its blast furnaces. From 1880 onward the reports of mounting daily output per furnace were greeted with incredulity in England and Europe. During each decade annual production in the United States nearly doubled. The British output increased but could not keep pace with that in the United States. By 1890 American production exceeded the British, and the United States became the world's leading iron and steel producer.

The industry also developed rapidly in Germany. The Ruhr became the leading blast furnace area of the continent, and output was supplemented from other expanding iron and steel regions such as Lorraine and Silesia. This growth reflected the general expansion of industry in Germany and particularly the specialization in the manufacture of iron and steel products. By 1910 the German output of pig iron exceeded the British—14,200,000 tons as against 11,100,00 tons. As these three were challenging the leadership of each other, the industry also had a significant growth in other European countries, particularly France, Belgium, and Russia.

The iron and steel industry did not develop simultaneously. Iron was the traditional product but its greatest weakness was a lack of durability. During the 1850's rails had to be replaced every four months even though traffic was not heavy. The means of satisfying the growing need for a more durable and resistant metal was found shortly after the middle of the nineteenth century. The steel era was born in 1856 when Henry Bessemer perfected the Bessemer process of making steel from pig iron.

In the Bessemer process, molten iron is poured into a pear-shaped tilting converter. A strong air blast is introduced through the opening at the bottom. The oxygen burns out the impurities in the pig iron, such as carbon, silicon, and manganese. This reaction generates enough heat for the operation, and no fuel is needed. The process requires about ten minutes, at the end of which time the iron is concentrated at the bottom of the converter, under a layer of slag. At regular intervals the iron and slag are tapped. Only minute quantities of impurities remain in the iron. Because the air blast generates compounds of gases, an alloy of manganese, iron, and other elements is added to the molten charge to remove them. The purified metal is steel. Although earlier methods of making steel produced a higher quality product, the main advantage of the Bessemer process was its rapidity, which made it possible to produce large quantities in a short time and at lower cost.

A few years later (1861) a second method, the open-hearth process, was developed simultaneously by William Siemens in England and the Martin brothers in France. In this process, gas or oil is used to heat the charge—pig iron, scrap, and flux—on a shallow hearth. The furnace has an opening at each end; gas and air enter at one end and the products of combustion escape through the other, with a reversal of flow every 15 or 20 minutes. Two regenerative chambers below the furnace, one at each end, are alternately heated and cooled. The molten steel and slag in the open-hearth are discharged at various levels. The process requires approximately 15 hours to complete.

The open-hearth process possesses several advantages over the Bessemer method. Because of the longer period of operation there is greater control of the steelmaking process, and a higher quality steel results. Samples for analysis can be taken at any time. Also, the use of scrap considerably increases the supply of raw materials for steel production. A greater amount of finished steel can be obtained from the same quantity of pig iron, and fewer blast furnaces are required for a greater tonnage of steel.

As a consequence of these new processes, steel production began to rise, while the price for steel was halved between 1856 and 1870. However, one major difficulty remained. Since pig iron made from the phosphorus-rich iron ores of England and France made a brittle steel of limited usefulness, steel production was essentially limited to the processing of nonphosphorous ores. Sweden and Spain supplied most of these ores, but before the steel industry could expand effectively a step was needed in the smelting process to eliminate the phosphorous in English and French ores.

Finally in 1878 a process was developed by Thomas and Gilchrist which solved the problem of utilizing phosphorus-rich ores. The Bessemer furnace was lined with a basic material, dolomite. In the smelting process the reaction between phophorus, oxygen, and lime keeps the phosphorus from combining with the steel, and it is subsequently removed in the slag. The Thomas-Gilchrist process, called the "basic" process in contrast to the "acid" Bessemer process, was widely adopted in Europe. By the mid-1880's the Thomas-Gilchrist process had also been applied to the open-hearth furnace. The first basic lining of an English open-hearth furnace with dolomite occurred in 1884. Here as in the United States the Siemens-Martin method proved to be most acceptable for domestic ores.

With the development of techniques making possible large-scale production, steel output in relation to iron rose rapidly. Steel, being more resistant to wear, began to replace iron. The first steel ship was built in England in 1865, but by 1888 more than 90 per cent of new ship construction was of steel. The production of iron rails, still a flourishing industry in 1870, had essentially been replaced by steel in 1890. World production of steel rose from about 560,000 tons in 1870 to about 13,500,000 tons in 1890, and continued to rise until 1929, when it reached 128,300,000 tons.

During the world depression of the early 1930's production dropped to little more than 40 per cent of the 1929 peak. However, production gained new vigor by 1937 under the stimulus of economic recovery and the preparations for World War II, and world output at this time was 148,200,000 tons. During World War II steel tonnage reached almost 175,000,000 tons. After a short recession at the conclusion of World War II, output has continued to rise steadily.

Steel production has become increasingly important in relation to that of iron since 1870. By 1929 steel production was 22,300,000 tons ahead of pig iron, approximately 42 million tons greater in 1947, and by 1961 about 75 million tons ahead. This increasing spread clearly indicates the growing importance of scrap as a raw material in the steel industry (11). It is more economical to use scrap in open-hearth and electric furnaces because the steel scrap has already been refined. A large admixture of steel scrap reduces the percentage of impurities to be burned out—and thus the volume of fuel consumed—and enables the process to be completed in a shorter period of time. In effect, a large consumption of scrap in the open-hearth furnace increases its capacity and diminishes the cost of fuel in relation to amount of metal refined. The use of scrap is also more economical because it replaces pig iron and thus decreases the need for primary smelting capacity. The initial blast furnace plant with its ancillary sintering, coking, and other facilities normally represents a much larger capital investment than a steel works (58). Reducing the size of blast furnace operations represents a saving in the cost of building a plant, as well as a considerable reduction in the cost of producing steel.

The availability of scrap and the character of the iron and steel industry determine to a large degree whether scrap is a major raw material in a country's steelmaking. Luxembourg often produces slightly more pig iron than steel annually. India is noted for a greater production of pig iron than steel. In contrast

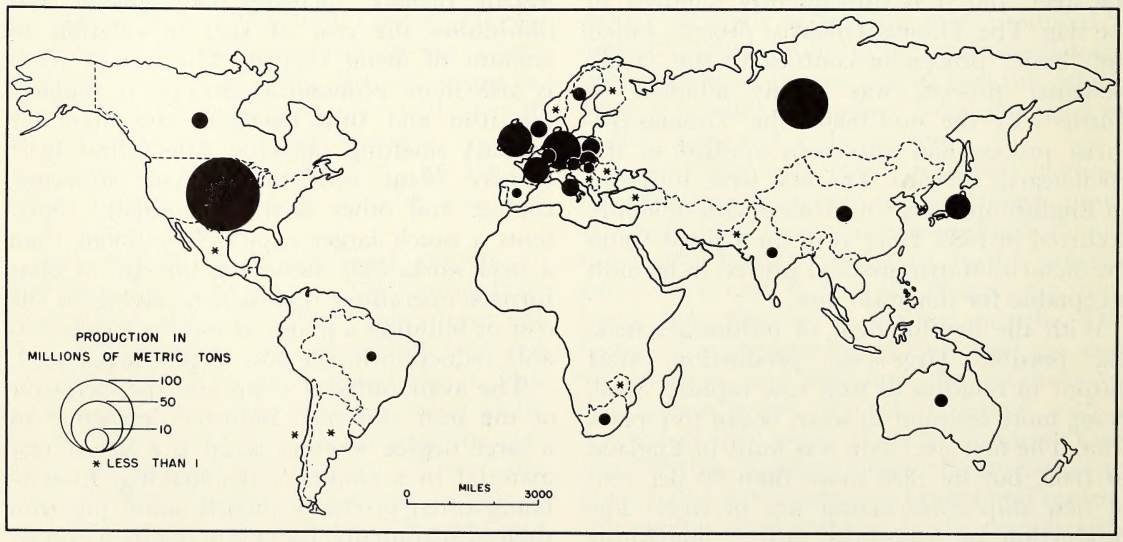
Japan, Italy, and Mexico rely heavily on imported scrap in producing considerably more steel than pig iron. In most of the heavily industrialized countries, when scrap is available steel becomes the dominant product.

The increase in iron and steel production was accompanied by a considerable rise in the number of producing countries. No less than 30 nations now have some iron and steel production. Nevertheless, six countries produce about 75 per cent of the world's pig iron and steel (Map 7.1). The United States is the world's largest producer with 25 to 30 per cent of the total. Within recent years output of steel in the U. S. has varied from 80 million to over 117 million tons depending upon economic conditions in the nation. Since 1930 the Soviet Union has experienced major growth in its iron and steel production, surpassing Germany and the United Kingdom, and now stands second in the world, producing about 20 per cent of total world output. The third major producer is the Federal Republic of Germany, with about 10 per cent of world production, followed by the United Kingdom with 7 to 8 per cent. In 1959 Japan surpassed France as the world's fifth largest producer of iron and steel. Important smaller steel producers include Belgium, Italy, Czechoslovakia, Poland, and Canada.

FACTORS OF LOCATION

Regional factors. The three major factors influencing the location of the iron and steel industry are, first, the coking coal producing areas, second, the iron ore producing fields, and third, the market for the finished products. The iron and steel centers of the world are located so that they will be in relation to combinations of these three basic factors (31).

The ideal location exists when coal, iron ore, and market coincide. This is a rare combination but it does occur at Birmingham, Alabama and was originally the case in the Scottish Lowlands and the Midlands of Britain. A common situation finds the coal field and market in the same region. Examples of this situation are the Ruhr area of Germany, the Donets Basin of the Soviet Union, and the Pittsburgh District in the United States. An iron and steel industry is also likely to develop where iron ore and market coincide. The developments in Lorraine, France and Krivoy Rog in the Soviet Union illustrate this type of localization. There is also the situation where coal and iron ore coincide, but the market is negligible. This is a rare occurrence, but does exist at Sydney, Nova Scotia, where coal and iron ore are found; the largest portion of the finished product,



7.1. World—Crude Steel Production—1960.

however, is marketed outside the local area in Canada.

Originally the iron and steel industry was strongly influenced in its location by its raw material base, particularly coal. There can be little question that such a location offers considerable advantages not only in saving transport costs but also in fuel economy at vertically integrated works such as the Ruhr industry. It now appears clear that, viewed in the long run, the relative advantages of traditional raw material orientation have been considerably reduced. The transport costs for the principal raw materials have been cut by progress in fuel economy, the extended use of rich ores, and the development of new processes for ore enrichment. The use of oil and electricity for heating purposes and of scrap as a raw material has also changed the locational conditions. As industrial regions develop away from coal and iron ore fields, a supply of steel is fundamental to their growth. The growing demand for high-quality steel and the corresponding need for close contact with the finishing processes have tended to increase the advantage of proximity to the steel market (17). In some instances the market may lie between the coal and iron ore. In this situation the industry develops in the market area. Examples of this type of location are Philadelphia and Baltimore on the Atlantic Coast, Gary-South Chicago at the south end of Lake Michigan, and Buffalo at the eastern end of Lake Erie.

When the coal area lies between the ore fields and the ultimate market, the iron and steel industry usually develops on the coal field. In this location the ore bulk is reduced on its way to the market. Germany's Saar, utilizing iron ore from Lorraine and marketing finished iron and steel in Germany, illustrates this type of location.

When the ore area lies between the market and the coal field, the iron and steel industry is oriented to the ore region. This situation does not occur often, but a number of small iron and steel plants have developed in this type of location. An example of this locational situation is at the Bilbao ore mining area of Spain, where coal is obtained from Britain and the finished iron and steel is marketed to the Spanish interior. In the United States, Duluth represents this type of location. The iron and steel industry developed at Duluth as a result of the availability of local iron ore with coal being transported to the area by lake freighters from the Appalachian fields and the finished iron and steel being sold in the markets to the west.

Besides the localizing factors of coal, iron ore, and market in the iron and steel industry, no other factor is of major importance. Limestone for fluxing (the process of promoting fusion) exerts a minor influence on the location of iron and steel plants, since it is used in smaller quantities than either coal or iron ore and is also more widely distributed. Ferroalloys used in the making of steel have no influence on plant location because of the small quantities consumed. Labor, capital, and taxes are of little or no importance in localizing this heavy metallurgical industry. Industrial inertia may stabilize the iron and steel industry in a region for a time after it has lost its original advantages. However, an uneconomic situation in a free enterprise society can not endure long. As the plant becomes antiquated it is not modernized, and operations are gradually abandoned as new iron and steel centers gain importance.

Site factors. The iron and steel plant is one of the largest industrial operations developed in modern times. A prime requisite in selecting a site for an iron and steel industry is the availability of land, not only for buildings but for the disposal of waste slag. A modest-sized iron and steel plant will extend a mile in length and several hundred yards in width. The development of a modern iron and steel industry in an established urban area is today virtually an impossibility. This is well illustrated by two modern examples. The Fontana plant located east of Los Angeles was built in a farming section. Similarly, the Morrisville plant north of Philadelphia was constructed on some of the best agricultural land in Bucks County, Pennsylvania.

A second factor affecting the site of an iron and steel industry is the availability of a water supply. Because water is used in this industry in larger quantities than any other raw material except air, the availability of water—from

underground, streams, or lakes—is the most important factor in determining the specific site of an iron and steel plant. Lack of water may prove a limiting factor in the growth of the industry in a particular place. It is now estimated that the entire flow of the Monongahela is used seven times by the iron and steel industry before the river empties into the Ohio at Pittsburgh. The ideal location for an iron and steel industry in relation to its water supply is on a large lake such as at Gary, Cleveland, or Buffalo on the Great Lakes.

The availability of transportation facilities is also a factor in locating the site of a plant. In order for a plant to function effectively there must be a continuous flow of raw materials into the plant and finished materials outward to a market. A tremendous amount of raw material is consumed by a steel plant. To produce one ton of pig iron requires about two tons of iron ore, one ton of coke, one-half ton of limestone, and four tons of heated air. Besides the one ton of pig iron produced, there is also one-half ton of slag and five tons of gas. In order to assemble such a vast quantity of raw materials the cheapest transportation is sought. Therefore, the location of a steel plant on a navigable waterway where large docks can be constructed is greatly desired. If this is not possible, the second choice for the site of a steel plant is at the convergence of land transportation routes, particularly railroads.

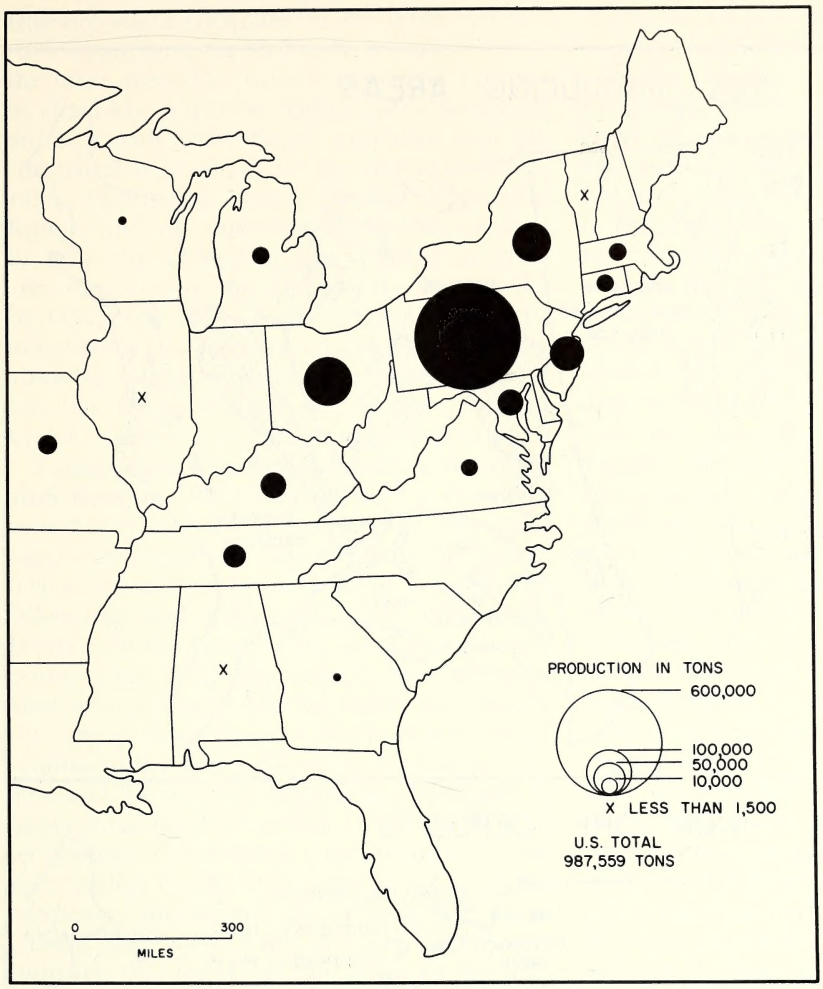
UNITED STATES

Early localization. The iron industry was one of the first types of manufacturing to develop in the United States, with the first iron furnace being built in Massachusetts in 1629. From the establishment of the first iron furnace until the middle of the nineteenth century the industry was widely scattered. Iron ore deposits were found in many places and charcoal from the virgin forests was omnipresent. The major factor in the establishment of a furnace was the demand for a local iron supply. Because transportation facilities were limited and iron was heavy, the operation could not bear the costs of long-distance hauling. Centralization was also impossible, since the iron ore deposits were small and no local area could provide sufficient charcoal to supply the furnaces for any extended length of time. Accordingly the early iron industry was transitory, with furnaces being moved or abandoned when one or another of the local raw materials became depleted.

The first iron district developed in the United States when anthracite was introduced in eastern Pennsylvania as a fuel about 1830. Although charcoal produced a higher quality iron, anthracite permitted the use of furnaces with greater capacity, and these were better able to serve the expanding market for iron in factories and railroad construction. Anthracite, although not a perfect blast furnace fuel, grew rapidly in importance, maintaining its dominance until the early 1870's.

Because anthracite was found only in northeastern Pennsylvania, the location of the iron industry became fuel oriented. However, the anthracite mining region developed only a small iron industry. This area was isolated and contained a minimum market for the finished iron. Consequently, anthracite was shipped out of the region, moving toward the iron ore deposits and, more important, the iron market of southeastern Pennsylvania. The precise location of the iron industry was determined by water routes such as the Lehigh, Schuylkill, and Susquehanna rivers. Coal could easily be floated down the canalized streams by barges, and iron ore was available from many small but widely scattered deposits. In the 1860's about 100 small iron ore mines alone were operating in the region, and the area was the country's major producer of iron ore. At this time southeastern Pennsylvania was producing more than half of the nation's pig iron (Map 7.2).

Factors in the migration to southwestern Pennsylvania. In the late 1850's a number of events occurred which resulted in the rapid migration of the iron industry center from southeastern to southwestern Pennsylvania. This movement began with the invention of the Bessemer converter in England in 1856. The Bessemer furnace was a major technical advancement, since it was not only larger than the anthracite furnaces, but it provided a cheap means of producing large quantities

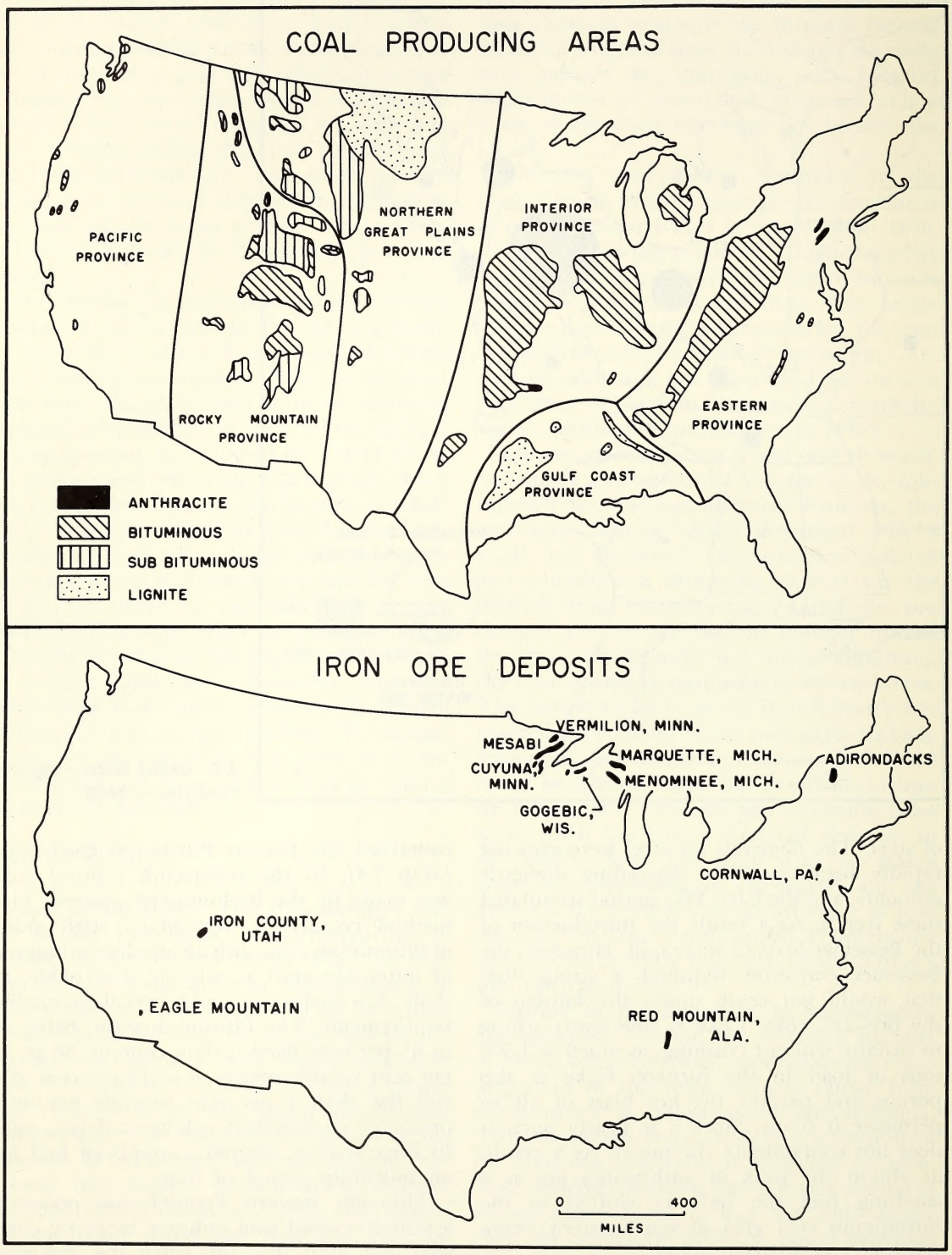


7.2. United States — Pig Iron Production — 1860.

of steel. The demands for steel were growing rapidly because of the expanding domestic economy, and the Civil War period stimulated these trends. As a result the introduction of the Bessemer furnace was rapid. However, the Bessemer converter required a strong fuel that would not crush under the burden of the ore—i.e., coke. Coke is sufficiently strong to sustain, without crushing, as much as 1,500 tons of load in the furnace. Coke is also porous and permits the hot blast of air to permeate it freely. Since it is nearly pure, it does not contaminate the metal. As a result, at almost the peak of anthracite's use as a smelting fuel the industry shifted to the bituminous coal area of southwestern Pennsylvania and adjacent states.

This area was particularly favored, as it contained the famous Pittsburgh Coal seam (Map 7.3). In the nineteenth century coke was made by the beehive-oven process. This method requires a particularly high grade of bituminous coal, with an absolute minimum of impurities such as sulphur, iron oxide, or shale. Few coal seams could meet these quality requirements. The Pittsburgh seam, being 57 to 65 per cent fixed carbon content, 30 to 35 per cent volatile matter, 4 to 14 per cent ash, and less than 1 per cent sulphur not only produced an excellent coking coal but, with its huge reserve, assured a supply of fuel for an indefinite period of time.

Although western Pennsylvania possessed a well-developed iron industry based on charcoal and local iron ore when the Bessemer converter was introduced, the local supply of



7.3. United States—Coal and Iron Ore Deposits.

iron ore was inadequate for the large furnace. As a result, iron ore had to be secured outside the local area. The nearest major reserve was in the Lake Superior region. This source of ore was made immediately available with the construction of the Sault Ste. Marie Canal in 1855. Production began in the Marquette Range, and was followed in the Menominee in 1877, the Vermilion and Gogebic in 1884, and the Mesabi—the greatest in the world—in 1892. The Lake Superior region owes its importance in iron ore production to the abundance, high quality, ease of mining, and low-cost transportation of the ore, shipped by lake freighter to the lower lake ports.

Youngstown-Wheeling-Johnstown metallurgical triangle. In the latter part of the nineteenth century the greatest iron and steel region in the world developed in the industrial zone outlined by the cities of Youngstown, Wheeling, and Johnstown. The Pittsburgh District, in the heart of the area, was the first center and long dominated the industry. However, a single district could not supply the rising demands and three nearby areas —Johnstown, the Mahoning-Shenango valleys, and Steubenville-Wheeling—developed as heavy metallurgical centers. This region with its mammoth industrial concentration in the river valleys is, like Germany's Ruhr, a citadel of heavy manufacturing. Pittsburgh is so closely associated with the iron and steel industry that most people think of the city as the steel capital of the world.

Pittsburgh District. The development of the Pittsburgh District as the nation's principal iron and steel center is primarily because of its strategic position in the assembly of Lake Superior iron ores and Pittsburgh seam coal from the Connellsville-Uniontown area (77). For the processing of the iron ore, the integrated iron and steel industry developed at the place of greatest advantage in transportation for the assemblage of raw materials, and the marketing of the finished products. This location was found to be in the Pittsburgh area along the valleys of the Monongahela, Ohio, and Allegheny rivers, which provided the low-level routes through the district. Because it required nearly two tons of coal to smelt one ton of iron ore, the Monongahela Valley, lying nearest to the coal fields, developed the greatest concentration of iron and steel furnaces.

In the decades of the 1870's and 1880's the Pittsburgh District became the metallurgical heart of the nation. As the district's iron and steel industry grew in importance, new industries that depended on steel migrated to the area, not only to be near their basic raw material—steel—but to save in freight charges on the transportation of the crude steel. The iron and steel industry and associated functions occupied most of the level land in the valleys. Scores of blast furnaces and associated rolling mills belched smoke into the congested valleys, and Pittsburgh became known not only as the "Steel City" but also as the "Smoky City." The industrial landscape was particularly striking at night when the Bessemer converters lit the sky with their radiance. Thousands of immigrants crowded into the narrow valleys until scarcely a square foot of space remained. Here developed the ultimate example of a heavy metallurgical region.

Although the modern iron and steel industry developed in this district nearly a century ago, the original factors which localized it are still present. Its relative share of the nation's iron and steel output has declined with the development of new areas, but it has maintained its nationwide market. Possibly the most significant trend in its iron and steel industry has been the growing emphasis placed on production of specialty stainless steels and other steel alloys. The iron and steel industry in the Pittsburgh District, as the cotton textile and leather industries of New England, is combatting the rise of new competitive steel areas by applying acquired skills toward producing quality steel. In this manner the Pittsburgh District remains a dynamic steel producing center.

Mahoning and Shenango Valleys. The evolution of the iron and steel industry in these valleys was similar to that of the Pittsburgh District (59). It evolved through a series of stages from the use of local fuels and raw materials to the assemblage of raw materials from distant sources and the growth of interregional markets. Today a steel industry, centered in Youngstown, dominates all other phases of economic activity. No other Ameri-

can steel city has such a concentration upon a single industry. The primary phases of the steel industry predominate, including the output of sheets, strips, structural shapes, rails, and bars rather than the production of finished steel products. The production of primary steel employs three-fourths of the workers in the Mahoning and Shenango valleys, whereas in the Pittsburgh District only two-thirds of the workers are in basic steel. The economic well-being of the district depends upon the quantity of steel produced.

The local market absorbs only a small percentage of the steel production. Therefore, the area depends on a national market. About two-thirds of the steel is sold in Ohio, Michigan, and Pennsylvania, but one-third must seek more distant markets. The largest single user of the steel of the Valleys is the automobile industry in the Michigan area. Fortunately large regional markets are nearby so that freight costs on the crude steel are relatively low.

Wheeling-Steubenville District. The first iron mill was constructed at Wheeling on the Ohio River in 1832. The city possessed two advantages for the growth of the industry (76). Within the local area was an abundant supply of coal, and the crossroads position provided an excellent route to the western markets. Because wooden buildings were in vogue in the nineteenth century nails were in great demand. Wheeling, by using the latest techniques in ironmaking and by producing a better-cut nail, soon became the nail capital of the nation. However, by the end of the century the wire nail came into use. Wheeling nail producers failed to comprehend the importance of the new nail, and between 1885 and 1900 lost most of their nail market. At the same time the district was converted to the making of primary steel products such as bars, sheets, pipe, and tin plate. Today the district is known for these products.

Johnstown. The Johnstown District lies to the east of Pittsburgh in the valley of the Conemaugh River. The city gained its first impetus as an iron manufacturing center at the head of the Western Branch of the Pennsylvania Canal. In the evolution of its steel industry, Johnstown has become a miniature Pittsburgh. It is basically a one-industry town, dominated by the Bethlehem Steel Corporation, whose plants, strung along the narrow valley, occupy more space than all other manufacturing combined. This congested valley presents a striking picture of intensive industrial use. The steel plants are aligned in the center of the valley, and residential areas cluster around the huge buildings. It is a typical nineteenth-century city, constructed when transportation was poor and workers were forced to live near the plants. In only a few places has the city been able to climb to the plateau, where beautiful homes and spacious shaded lawns occur. The fresh environment of these upland residential suburbs is in striking contrast to the smoke pall that fills the valleys and begrimes the workers' homes.

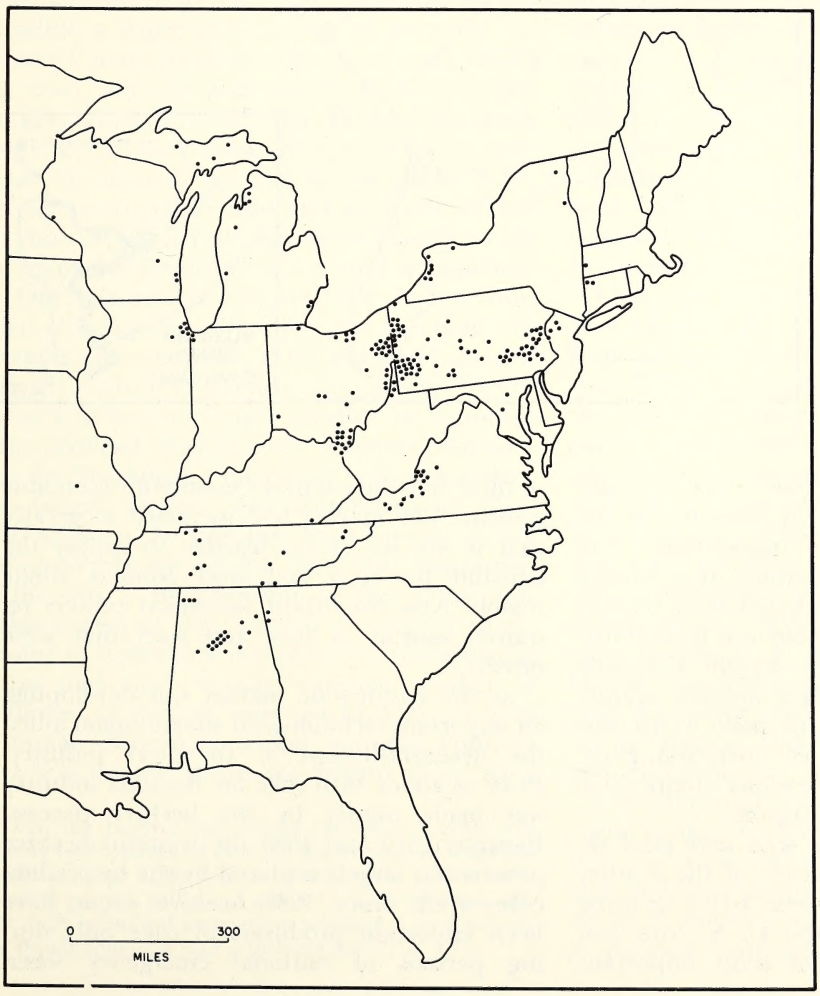
Importance of valley localization. One of the significant aspects of the localization of the iron and steel industry in this triangle is its concentration in the river valleys. These valleys possess many advantages for the establishment of a heavy metallurgical industry. Fundamental to the successful operation of the iron and steel industry is the ability to have uninterrupted assemblage of the bulky raw materials, and also to move the new crude steel to its market without delay. Railways hug the river banks which provide the least grade for the movement of the heavy materials. Waterways are routes providing the lowest-cost transportation in the region. Coal, coke, and limestone are transported from the mines and quarries to the steel plants, and increasing tonnages of steel are shipped by inland water routes from the Pittsburgh area to New Orleans and the Gulf Coast. The movement of raw materials and iron and steel industry products makes the traffic on the Monongahela River the heaviest of all rivers in the United States.

Because of the tremendous consumption of soft water in the iron and steel plants for cooling purposes and other industrial uses, the riverside location of the plants is of considerable value. It would be almost impossible to supply the water requirements of the steel industry in this region from underground wells.

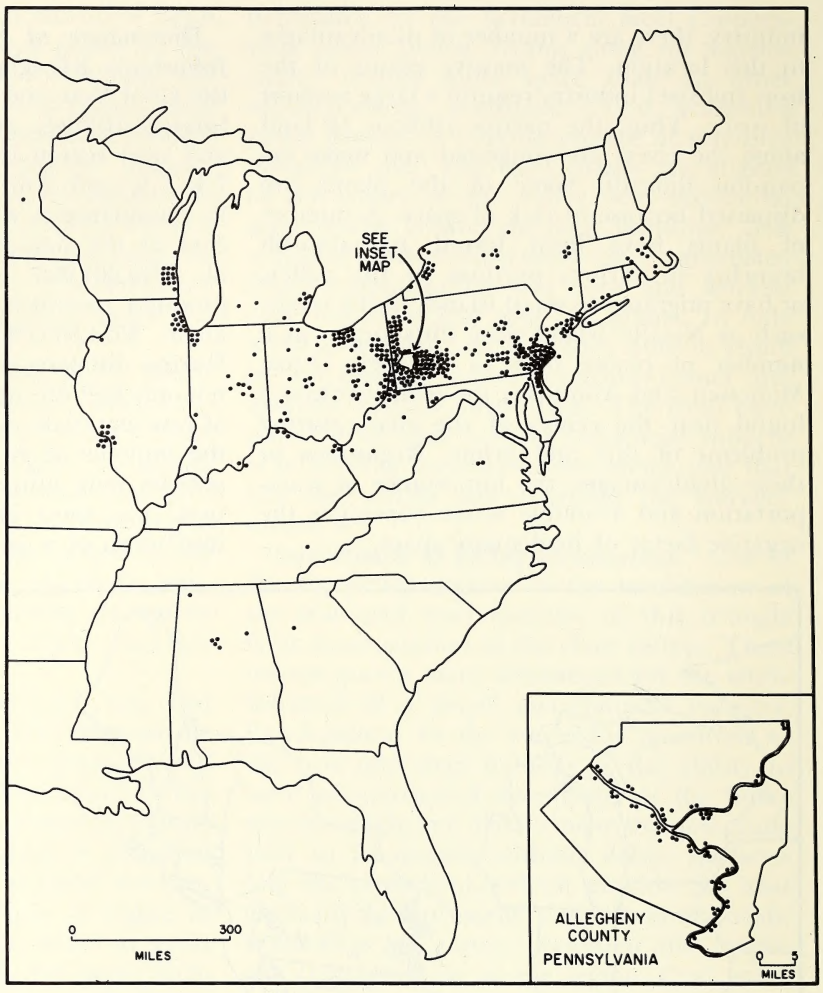
Although the river valleys have proved the most desirable location for the iron and steel

industry, there are a number of disadvantages to this location. The massive plants of the iron and steel industry require a large amount of space. Thus, the narrow ribbons of land along the rivers are congested and make expansion difficult. Some of the plants are dispersed because of lack of space. A number of plants have been forced to establish branches in various portions of the valley, or have migrated to small islands in the rivers, such as Neville Island near Pittsburgh. In a number of places such as Carnegie, Etna, Monessen, and Aliquippa the giant works are found near the center of the city, creating problems of dirt and grime. Regardless of these disadvantages, the importance of transportation and available water outweighs the negative factor of inadequate space.

Dominance of the Youngstown-Wheeling-Johnstown triangle. In the period between the Civil War and World War I, this metallurgical triangle grew to be the major iron and steel region in the United States (Maps 7.4, 7.5, and 7.6). In 1914 at the peak of its dominance it was producing about 70 per cent of the nation's steel. Of a total value of $918,664,000 worth of iron and steel products produced in the United States, about $674,000,000 came from this region. During this long period of growth the region not only had the advantages of easy assemblage of raw materials, central market location, and the impetus of an early start, but economic policies were initiated to discourage competition. The most important of these was the institution of a controlled freight rate system



7.4. United States—Blast Furnaces—1909.

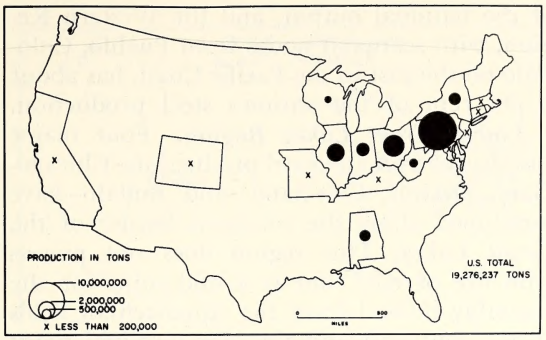


7.5. United States — Steel Works and Rolling Mills — 1909.

known as "Pittsburgh Plus." Its primary purpose was to stabilize the industry in the region by discouraging competition. The policy operated in this manner. If a Kansas City, Missouri buyer purchased steel from a Gary, Indiana plant, he paid the f.o.b. Pittsburgh price, and also the freight rate (the "Plus") that would have been assessed against shipment from a Pittsburgh mill. With this system of freight charges in operation, Pittsburgh was given a tremendous competitive advantage over all other regions.

Decentralization of the iron and steel industry. Since the first decade of the century a number of forces have been active favoring the decentralization of the U. S. iron and steel industry. Possibly the most important of these was the country's mammoth economic growth. The market had increased so greatly that it was no longer feasible to supply the demand for iron and steel from a single region. New important industrial centers required sources of iron and steel that were nearby.

As the nationwide market was developing, an important technological advancement aided the decentralization of the steel industry. Prior to about 1910 coke for the steel industry was made mostly by the beehive process. Between 1910 and 1925 the wasteful beehive process was largely replaced by the by-product coke oven. Since 1930 beehive ovens have been important producers of coke only during periods of national emergency when



7.6. United States—Steel Production—1909.

by-product ovens could not supply the demands. The by-product oven had a number of advantages over the older beehive process. The by-product coke ovens not only saved the valuable coal tars and gases, but made possible a wider distribution of the coke industry.[1] A much greater range of coals could be used, and the fuel supply was no longer so geographically restrictive. Because the gases from by-product ovens were utilized to preheat the furnaces as well as the plant, these ovens developed at iron and steel plant sites. It thus became advantageous to transport coal to many market-oriented iron and steel plants.

Other factors also encouraged decentralization. Among these were the alterations in the freight rate structure. With the rapid growth of the industry, particularly during World War I, it was no longer possible to maintain the artificial freight rate structure imposed by the Pittsburgh Plus system, and this system of freight charges was abandoned in 1924. In its place the multiple basing-point system of determining freight rates was instituted. This was a modification of the Pittsburgh Plus system in that instead of using a single point to determine the price for transporting iron and steel to the national market, a number of centers were established, such as Chicago, Birmingham, and Sparrows Point to serve as basing points for freight rates. As a result, prices for iron and steel were quoted in terms of the nearest basing point—called the "governing basing point"—plus the appropriate charges for transportation and extras. This in reality established a system of regions in which a plant or group of plants had a competitive freight advantage (15).

Both the single and the multiple basing-point systems were sources of considerable controversy. The major criticism was that the system provided the basis for geographical price discrimination, since it eliminated regional price competition. After 24 years of operation, the iron and steel industry abandoned the basing-point system when, in July 1948, the U. S. Supreme Court declared it to be illegal. Since 1948 the price of steel at any destination has been determined by the f.o.b.-mill pricing policy. This system is based on the price of the steel plus freight charges from the point of origin to the point of destination. As a result of the changed freight structure, a number of companies have built plants in new areas in order to compete in the steel market. A notable example of this trend is the development by the United States Steel Corporation and the Bethlehem Steel Company of iron and steel facilities on the Atlantic Coast.

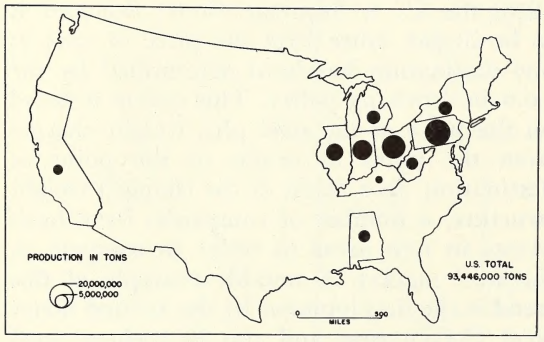
Changing sources of raw materials have also affected the location of the iron and steel industry. Although the original reserve of iron ore in the Lake Superior ore ranges was enormous, huge demands for more than half a century have reduced the supply of high-grade ore, so much so that a depletion problem is beginning to face the industry. The iron and steel industry has recognized that Lake Superior ores are exhaustible and that new sources must be sought in foreign areas such as Canada, Venezuela, Brazil, and other countries. Because these ores enter the United States through port cities, there has been a growing tendency to develop iron and steel plants at port cities such as Baltimore and Philadelphia.

Governmental policies have also been influential in the decentralization of the American iron and steel industry. The construction of iron and steel plants in strategic locations has occurred under government subsidies during a national emergency. For example, the

[1] In the beehive coke ovens the only product was about 1,000 pounds of coke. In the by-product oven the yield is about 1,200 pounds of coke, plus 10,500 cubic feet of gas, 7.1 gallons of tar, 2.4 gallons of crude oil, 20 to 25 pounds of ammonium sulphate, 5 to 6 pounds of liquid ammonia, and a little toluol.

Fontana plant east of Los Angeles was built by the government during World War II to supply steel to west coast shipyards and other war plants.

Location and trends of the modern industry. The capacity of the iron and steel industry has increased steadily in the twentieth century. In 1914 steel ingot capacity was about 45 million tons. In 1938 it was 80 million tons and in 1961, about 130 million tons. Actual production of steel has also risen from about 27 million tons in 1914 to a peak of 117 million tons in 1955. Since then, annual output has varied from 85 million to 115 million tons.



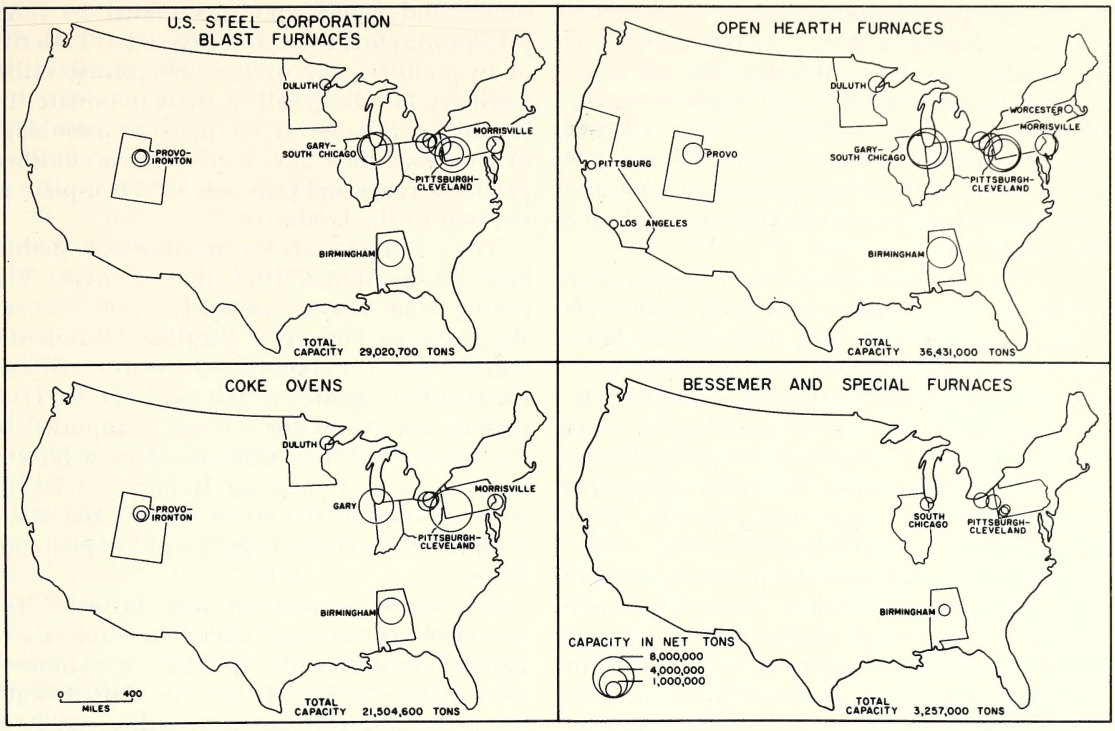
7.7. United States—Steel Production—1959.

Utilization of the furnaces has fluctuated from less than 20 per cent of capacity during the economic depression of the 1930's to nearly 100 per cent of capacity during World War II. In 1955, the peak year of output, about 86 per cent of the steel capacity was utilized. Of the total tonnage of steel ingots produced about 90 to 91 per cent is made in open-hearth furnaces, 6 to 7 per cent in electric furnaces, and 3 to 4 per cent in Bessemer converters.

United States steel production is concentrated in five regions (Map 7.7). The Youngstown-Wheeling-Johnstown area has about 35 per cent of the domestic steel output. The Lower Great Lakes Region extending from Chicago through Detroit and Cleveland to Buffalo produces about 43 per cent of the nation's total. The Atlantic Coast from Bethlehem to Baltimore has an output of about 10 per cent. With production centered in Birmingham, the South possesses about 5 per cent of the national output, and the Western Region, with scattered nodes from Pueblo, Colorado on the east to the Pacific Coast, has about 6 per cent of the nation's steel production.

Lower Great Lakes Region. Four major districts of iron and steel production—Chicago-Gary, Detroit, Cleveland, and Buffalo—have developed along the southern border of the Great Lakes. This region does not possess iron ore or coal, but is a mid-point for the assembly of coal from the Appalachian fields to the southeast and the lake terminal point for the movement of iron ore from the Lake Superior region. For marketing the steel the iron and steel centers are thus at the break-of-bulk point in the transportation lines along the southern margin of the Great Lakes. In summation, this region's intermediate position between fuel and raw materials and location in the heart of one of the nation's largest steel markets gives it an advantage in the competitive growth of the iron and steel industry.

Chicago-Gary District. The iron and steel industry of this district had its initial growth in the late 1860's after the opening of the iron ore deposits of the Lake Superior region. The industry grew steadily, and by the 1880's Chicago ranked fourth among the iron and steel centers of the United States. However, the iron and steel industry here remained relatively small until 1906, when the United States Steel Corporation built its mammoth plant at Gary, Indiana (Map 7.8). Gary is a good example of a scientifically planned industrial location. Its locational advantages include being at a crossroads position, where the cheapest direct route between coal and iron ore crosses the major east-west routes, and being in the heart of a tremendous market, an available large and skilled labor supply, and a center of business—which aids management as well as facilitating financial transactions. The site advantages were also important in that the area was sandy and largely devoid of economic development, there was sufficient level land to accommodate the large steel plant, its situation at the southern edge of Lake Michigan gave the plant an almost unlimited water supply, the distance from the center of Chicago avoided high taxes and high land prices during the initial years of develop-



7.8. United States—United States Steel Corporation.

ment, and the laws of Indiana were more favorable to industrial development than those of Illinois.

Detroit District. Although the Detroit District is the largest consumer of steel in the United States because of its automobile industry, iron and steel developed late in the area, and this district is still a relatively small producer. Other iron and steel centers possessed slight cost advantages in converting iron ore into steel. It was thus cheaper to transport the finished steel to Detroit than to assemble the raw materials and produce steel in the area. However, it will be only a matter of time until the automobile steel market compels the enlargement of the present steel industry.

Cleveland District. In the transporting of iron ore from the Lake Superior region to the Pittsburgh District, the Lake Erie ports of Cleveland, Lorain, Ashtabula, and Conneaut were the break-in-transportation centers. With the availability of iron ore and nearby sources of coal, an iron and steel industry developed in Cleveland at the same time that the iron and steel centers were growing in the Youngstown-Pittsburgh region. Although this city specializes in steel, its role is much less important than in the interior Appalachian districts. Also, it is largely a center of iron and steel products rather than primary iron and steel. Noteworthy is a long list of steel products such as electrical machinery, motor vehicles, machine tools, hardware, wire, and others. Cleveland's manufacturing landscape is characterized not only by blast furnaces and rolling mills but by a variety of metalworking plants.

Buffalo District. The leading industry in Buffalo is iron and steel, with the district accounting for one-half of all workers engaged in the production of primary metal in New York state. The development of this industry at Buffalo has had a long history, but it was not until 1900, when the Lackawanna Iron and Steel Company selected Buffalo as its center of operations, that noteworthy activity began. The Buffalo site was chosen because

of the adequate water supply, the existence of lake shipping and rail facilities, and the availability of iron ore through low-cost water transportation from the Lake Superior region. The advantages of Buffalo for this industry can be realized to some degree by the fact that in 1912 Buffalo was producing iron and steel for 65 cents a ton cheaper than was the Pittsburgh District.

In 1922, the Bethelehem Steel Corporation purchased the Lackawanna Iron and Steel Company plant, including all facilities. Since this purchase, Bethlehem Steel has dominated the metals industry in Buffalo, currently employing 16,000 to 18,000 workers, or over one-half of those employed in primary iron and steel in the district. Six other companies operate here. The total steel capacity of the area is about 6,250,000 tons annually.

Serving to perpetuate the primary iron and steel industry in the Buffalo District has been the growth of metal fabricating, machinery, and transportation equipment industries. The supply of sheet steel produced here has been a factor in influencing the establishment of branch plants of the Ford Motor Company and the General Motors Corporation.

Atlantic Coastal Region. The smelting of iron ore is one of the region's oldest industries. Although the original operation was based on local raw materials, the iron ore deposits of the Adirondacks, Cornwall, and Morgantown provide only a part of the iron ore consumed in the region today. The present iron and steel industry exists in the area not because of raw materials, but because of the large market for iron and steel.

Southeastern Pennsylvania. Bethlehem and Steelton, a suburb of Harrisburg, can trace the origin of their iron and steel industry to the colonial period when bog iron ore and charcoal were the basic raw materials. Of the two centers, Bethlehem has become a major industrial city, concentrating on the manufacture of steel. A single organization, the Bethlehem Steel Corporation, employs over half the workers of the city, and nearly three-fourths of the workers are employed in metals and metal product industries. The steel industry, stretching along the Lehigh River, presents a spectacular view of a heavy metallurgical complex. Blast furnaces belching smoke and flames and surrounded by huge piles of iron ore, coke, and limestone; batteries of by-product coke ovens; vast rolling mills; auxiliary buildings—all of these dominate the landscape. Because of the massive assemblage of raw materials and marketing of finished products, roads and railroads are a conspicuous element of the landscape.

The raw materials for Steelton and Bethlehem are assembled from diverse areas. The coking coal comes primarily from western Pennsylvania and West Virginia by railroad, and the iron ore comes from the Adirondacks, Cornwall-Morgantown, and the Lake Superior region; but the major portion is supplied by imports from Chile, Canada, Venezuela, and other sources. Limestone is quarried locally from deposits in the Great Valley, and water is obtained from the Lehigh and Susquehanna rivers.

For many decades no new primary iron and steel centers were added in southeastern Pennsylvania. Finally in 1951 a mammoth new plant was started by the United States Steel Corporation at Morrisville, north of Philadelphia. This was the first primary iron and steel plant built by this firm on the Atlantic Coast. With the abandonment of the regional basing-point system for determining freight rates in 1948, the United States Steel Corporation found itself at a cost disadvantage in marketing steel in this region. After a careful survey of potential sites on the seaboard, Morrisville was selected as being most advantageous for the assembly of raw materials and the marketing of the finished steel (4).

The site of this plant was selected in the heart of the rich farming lands of Bucks County, Pennsylvania. A new, completely integrated plant with an annual capacity of 1,800,000 tons of steel, now occupies a space that was once equivalent to 50 Pennsylvania farms. The location on the Delaware River is advantageous for the low-cost assembly of raw materials. Some iron ore comes from the Lake Superior region through the port of Erie, but most comes from foreign sources. Much of the coal comes from the West Virginia fields, from which it is first transported by railroad to Norfolk, Virginia, and reshipped by coastal barges directly to the steel mills.

Since many of the ferroalloys are imported the tidewater location is also advantageous for their assemblage.

Sparrows Point, Maryland. The modern iron and steel industry was established at Sparrows Point in 1887 in order to utilize foreign iron ores and has flourished as a result of its growing market and ready access to West Virginia coking coals. The most important industry in Baltimore is represented by its steel works and rolling mills. Sparrows Point, a one-company town, is a typical heavy industry community, completely dominated by the large steel plant. As a result of the availability of steel many other industries, such as foundries and machinery, have migrated to Baltimore.

The South. Prior to the Civil War the iron industry was widely scattered, with many small centers in Virginia, Kentucky, and Tennessee. At the conclusion of hostilities the iron industry all but disappeared. The modern industry dates from about 1876 with the development of iron furnaces in the Birmingham area. This area still dominates the region and has almost three-fourths of the South's steel capacity. Ranking next to Birmingham is the coastal area of Houston, Texas with one-fourth of the South's capacity. Between 1940 and 1955 the South's steelmaking about doubled. With an expanding industrial economy, it can be expected that this will continue to be a dynamic steel region (12).

Birmingham, Alabama. The Birmingham District possesses unique advantages for the development of an iron and steel industry in having within the local area extensive deposits of coking coal, iron ore, and limestone. Nature has assembled the raw materials so advantageously that they need only be transported a few miles.

Two major deposits of iron ore lie within the district. The largest deposit, found in Red Mountain adjacent to Birmingham, supplies about 90 per cent of the ore consumed. A massive seam of hematite extends along the base of the mountain for more than 25 miles. The seam varies from 15 to 22 feet in thickness, and the ore averages 30 to 40 per cent in iron content. The disadvantage of low-grade ore is partly overcome since a large percentage of the ore contains limestone and is self-fluxing in the furnaces. Because the ore is deep all mining is underground.

In contrast to the underground mining of hematite ores at the foot of Red Mountain, the limonite ore deposit near Woodstock, Alabama is mined by the open-pit method. The ore after beneficiation contains from 41 to 54 per cent iron content. It is then mixed with the hematite to upgrade these ores. Woodstock deposits, however, are irregular and variable and have never been the basis of the Birmingham industry.

Three coal fields, of which the Warrior is of coking quality, lie near Birmingham. The Warrior field embraces about 3,500 square miles. The seams are three to seven feet in thickness, and reserves are probably over 3 billion tons. The coal is processed in by-product ovens at the steel plants. Because of available by-products a chemical industry has evolved in Birmingham.

Besides the advantages of local raw materials this region possesses a large, cheap labor supply similar to that used by the textile industries. Birmingham also enjoys excellent transportation facilities. Not only do major railroad lines enter Birmingham, but a canalized waterway to the Gulf of Mexico offers a low-cost water route to the southern coastal markets. The market for iron and steel in the South was relatively small until World War II, but with increasing industrialization the market has grown rapidly. In the past much of the iron and steel was consumed in the city of Birmingham in its metals industries, which produce mining machinery, cotton gins, sugar mill machinery, and other metal products. More recently, the steel has been shipped throughout the South. In many ways Birmingham occupies a position in supplying the South similar to Chicago's position in the Midwest. With growing demands for this basic industrial commodity, the iron and steel industry of Birmingham faces a bright future.

Western Region. The Western Region embraces a large territory with plants at widely scattered points (3). Outstanding districts of production are at Fontana, California and Provo, Utah. These two districts have nearly three-fourths of the West's steel capacity. Smaller centers of steel production exist at

Pueblo, Colorado and Pittsburg, California. This is the most rapidly expanding steel producing region in the nation. Between 1940 and 1960 steel capacity more than trebled in the region. Future growth of the industry will depend on the steel market of the western states (38).

Provo, Utah. The first modern blast furnace was erected in this area in 1924, but the industry remained small until World War II. During the war period there was a tremendous demand for iron and steel on the Pacific Coast. As a result the Defense Plant Corporation controlled by the United States government built an integrated steel mill at Geneva, Utah, near Provo. Its original cost was $200,000,000, and production began in December 1943.

Iron ore, averaging 54 per cent metallic content, comes from Iron Mountain, 225 miles to the southwest. Bituminous coal of coking quality is mined in Horse Canyon, 120 miles to the southeast. Limestone is quarried at Payson, 35 miles distant. The location of the plant was determined at the point of greatest advantage for the assemblage of raw materials and marketing of the finished steel. Its location on a major east-west railroad route was essential, since Utah uses little steel. Its principal market is in the Los Angeles and San Francisco areas of California.

The area also had the advantage of a supply of high-quality labor and the availability of water from Utah Lake at relatively low cost. The Geneva plant was originally designed to produce heavy plate and structural steel, primarily for shipyards. At the end of the war the mill had to be converted to make thinner sheets of steel for industrial use. The government sold the plant to the United States Steel Corporation for about one-fourth its original cost.

At the termination of World War II it was questioned as to whether the Geneva plant could compete favorably with the iron and steel plants of the East. It now appears that the Geneva plant is well located. The increasing demand throughout the West for iron and steel in construction, public utilities, mining, and manufacturing has bolstered the industry. There is also the factor that national security has encouraged the continued decentralization of the iron and steel industry.

Fontana, California. The Pacific Coast states lacked blast furnaces for smelting iron ore until World War II. As the demands for steel rose on the Pacific Coast the problem of supplying the area from the East became increasingly great. Not only was steel in short supply, but the great distance added substantial difficulty to shipping the steel across the nation. The railroads were overburdened in hauling war equipment, and the water route via the Panama Canal was menaced by German submarines.

The tremendous market, particularly for steel for the shipyards, was the paramount factor in the building of an integrated iron and steel plant at Fontana, California, 50 miles east of Los Angeles. Although the market was present, the assemblage of raw materials for the plant presented a difficult problem. Most of the coking coal consumed comes from Sunnyside, Utah, 800 miles to the northeast. The iron ore comes largely from Eagle Mountain, some 160 miles from the plant. This mining area ships about two million tons of ore annually. Ore beneficiation began in 1954 to improve blast furnace operations and to reduce transportation charges. The ore content has been raised from 51 to 56 per cent. Two 65-car ore trains move daily over 51 miles of private track to the junction of the Southern Pacific Railway at Ferrum near the Salton Sea, from which point the ore cars are delivered to Fontana. The limestone for the plant is obtained locally. Scrap is another raw material of importance. This area with its large number of metal fabrication plants is the major scrap center of the Pacific states. Prior to World War II, 500,000 tons of scrap were exported annually. However, with the demands of the open-hearth furnaces, it is now a deficit area and scrap from western United States comes to the region.

Beginning in 1946 the plant was converted from wartime to peacetime production. The plant, originally built at a cost of $100,000,000, has been enlarged several times and now includes some of the nation's largest blast furnaces, by-product coke ovens, open-hearth furnaces, and other facilities.

The Fontana plant is located in a dry region, and availability of water has been a problem. Owing to the extreme need for

economy, an elaborate water recovery system has been introduced. As a result the water requirement for a ton of steel is only 1,400 gallons, compared to a national average of 65,000 gallons. It is estimated that each gallon of water is theoretically used more than 40 times before it evaporates or is lost.

SOVIET UNION

Distributional pattern during tsarist period. The Russian iron industry had its origin prior to 1700 in the heart of the Moscow region. The early furnaces were located near Tula, Kashira, Serpukhov, south of Moscow, and near Lipetsk. A secondary region developed near Lake Onega. The local availability of iron ore and charcoal and a nearby market were the major factors in the establishment of the early centers of production.

After 1700 during the regime of Peter the Great the demands for iron rose, and the small furnaces of the Moscow area were unable to supply the growing market. The center of production shifted eastward to the Urals, where it remained until the latter part of the nineteenth century. The Urals possessed advantages for the establishment of an iron industry in their large resources of high-quality iron ore, the presence of huge wooded areas, and the abundance of water in mountain streams. During this period charcoal provided the source of fuel for smelting the ore, and falling water created the air blast for the furnaces. At the peak of Urals production (about 1855), approximately 75 per cent of Russia's output of 460,000 tons of iron came from this area. At this time the Moscow area produced about 13 per cent and the South nearly 9 per cent.

Toward the end of the nineteenth century the iron and steel industry underwent another major shift in location. With growing demands, particularly due to increased railroad construction, the small charcoal furnaces were unable to supply the market. The industry shifted to the Donets Basin of eastern Ukraine. The coking coals of the Donets area made possible the utilization of larger furnaces. The proximity of Krivoy Rog iron ore, and the influx of foreign capital and technical improvements aided the development. By 1913 the Donets area produced 73.6 per cent of the Russian total output of 4,300,000 tons of pig iron. The Urals produced only 12.5 per cent and the Moscow area about 5 per cent.

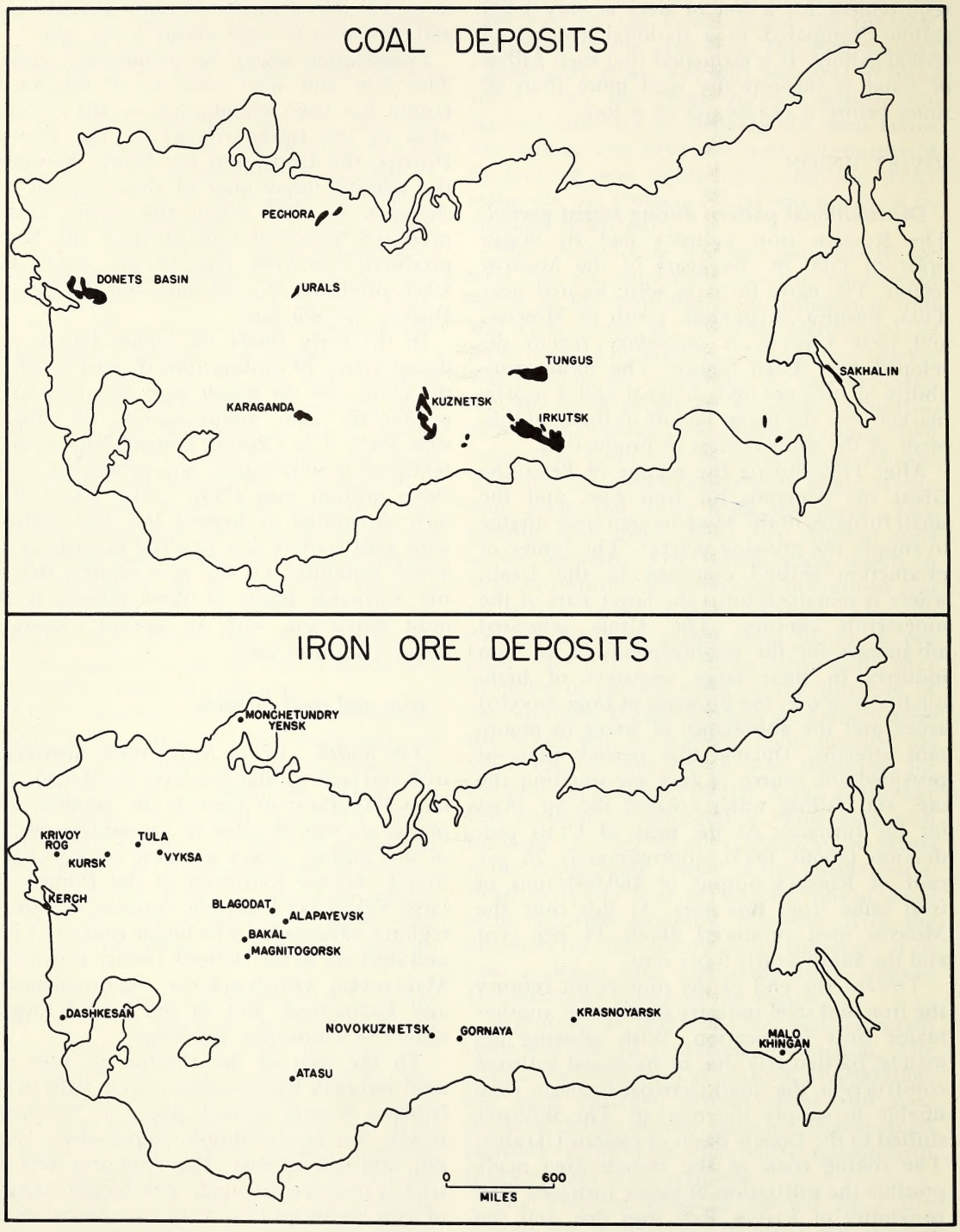
Localization under the communist regime. The iron and steel industry of the Soviet Union has been maintained by the communists in the tsarist centers of the Central District, the Urals, and the South. However, the relative importance of these regions has changed. In 1928 when the Soviet Union produced 4,250,900 tons of steel, the South produced 2,409,100 tons of the total. The Urals produced 995,300 tons, and the Central District 377,500 tons.

In the early 1960's the Soviet Union produced about 70 million tons of steel of which the Urals and the South were about equal in production with approximately 30 million tons each. The Central District has declined relatively in importance, now producing about three million tons (Map 7.10). The Soviets have attempted to disperse the steel industry with steel centers now existing in each of the Soviet republics. Of the new centers, that of the Kuznetsk Basin of West Siberia is the most important, with an annual output of about 7 million tons.

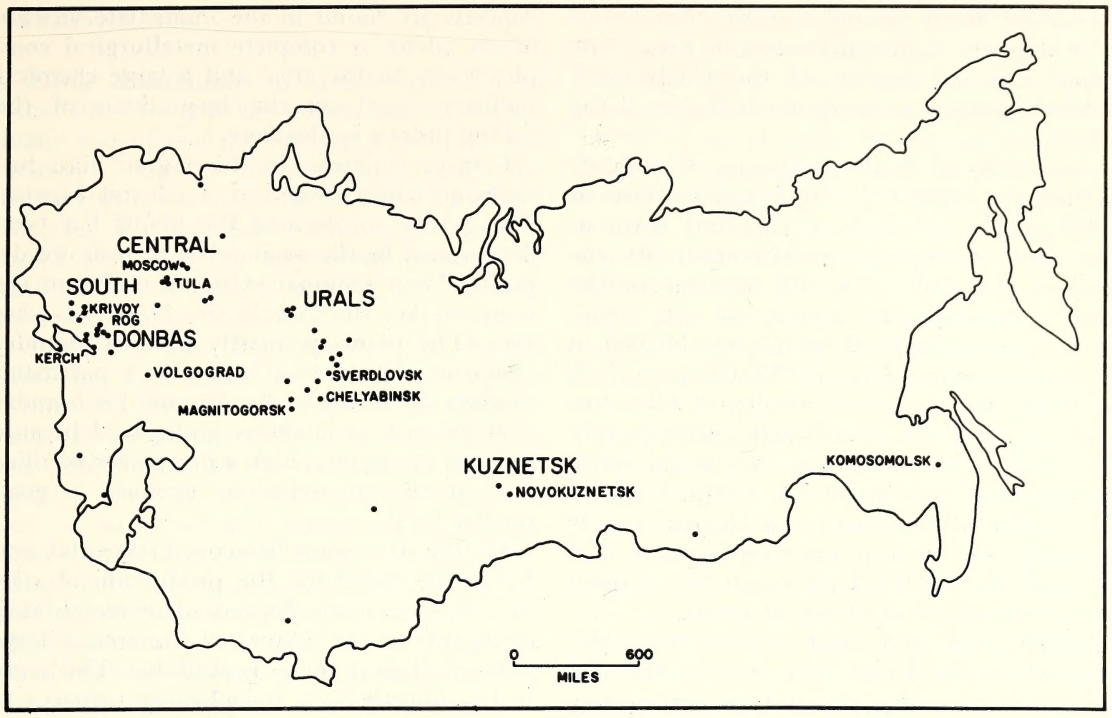
Iron and steel districts

The South. In the South three districts of iron and steel production have developed. The most important of these is the Donbas. The plants are concentrated in the western section of this region, where the best coking coal is found. To the southwest of the Donbas the large Yelenovka limestone deposits add to the region's advantages. The major centers of iron and steel are in the Donetsk Oblast at Donetsk, Makeyevka, Ordzhonikidze, Konstantinovka, and Kramatorsk and in the Voroshilovgrad Oblast at Voroshilov and Sergo.

To the west of the Donbas an iron and steel industry has developed since 1930 in the Dnieper Region at such places as Dnepropetrovsk, Dneprodzerzhinsk, Zaporozhye, Nikopol, and Krivoy Rog. This iron and steel district is iron-ore oriented. The largest deposits of iron ore in western Russia are found in the region at Krivoy Rog. The development of the iron and steel industry of the Dnieper Dis-



7.9. Soviet Union—Coal and Iron Ore Deposits.



7.10. Soviet Union—Iron and Steel Metallurgical Centers.

trict is complementary to that of the Donbas. Formerly the railroads carrying iron ore from Krivoy Rog to the Donbas returned empty, since no cargo was available. With the development of the Dnieper iron and steel region, coal provided a return cargo. The Dnieper Region is also favored in the development of its iron and steel industry by having a more adequate water supply than the Donbas and extensive reserves of manganese at Nikopol.

Besides these two major districts, several isolated centers of iron and steel production have developed. A plant has been built at Kerch on the basis of iron ore from the Crimean Peninsula. The plant of Mariupol is advantageously situated between the Donbas coal and the iron ore of Kerch. Other small plants are at Taganrog and Krasny Sulin.

Urals. Prior to the communist revolution the Urals iron and steel industry was small and technically backward, being based exclusively on charcoal. The modern developments date from May 15, 1930 when the Soviets decided to organize the Urals-Kuznetsk Combine. Under this plan integrated iron and steel industries were built at Magnitogorsk in the Urals and at Novokuznetsk in the Kuznetsk Basin. As a result of the coordinated plan Kuznetsk coal was sent by rail to the Urals, and the iron ore was shipped from Magnitogorsk in the opposite direction.

The creation of the Urals-Kuznetsk Combine required extensive construction of new railroad facilities. A new double-track line was laid from the Kuznetsk area to the Urals, and local improvements of the railways were made in the Urals and in the Kuznetsk. The distance between the coal of the Kuznetsk and the iron ore of the Urals is more than 2,000 miles.

Within the Urals the Chelyabinsk Oblast, with iron and steel centers at Magnitogorsk and Chelyabinsk, is the primary iron and steel production district. The chief factor attracting the iron and steel industry is the availability of iron ore. The principal mining districts are Magnitnaya Mountain at Magnitogorsk, Bakal and its mining center of Rudnichny to the south (with some of the highest grade iron

ore of the Soviet Union), and the titaniferous iron deposits of Magnitka, east of Kusa. The total iron ore reserve of the Chelyabinsk Oblast amounts to about one-half that of the Urals.

Magnitogorsk is the prototype of the new communist industrial city. It was founded in 1931 on the left bank of the Ural River at the foot of Magnitnaya Mountain. By the end of the 1930's this city was one of the larger metallurgical centers of the Soviet Union. Its population, which was 146,000 in 1939, now is approximately 300,000 persons. A complete metallurgical complex of blast furnaces, coke ovens, open-hearth furnaces, rolling mills, chemical works, and metal fabricating plants exist in the city. A large reservoir on the Ural River provides an adequate supply of water for the iron and steel industry, and a lignite-fed 100,000 kilowatt electric plant is the main source of electrical power.

Other iron and steel centers have also thrived in the Urals. The best of the old, charcoal consuming plants have been reconstructed and modernized. These plants produce specialized high quality metal. As a result of the demands for iron and steel during World War II, the traditional charcoal-iron producing city of Nizhniy Tagil was developed as a new, modern iron and steel center. It is now said to be approaching the size of Magnitogorsk. Nizhniy Tagil lies in the center of an important iron mining district. A complete metallurgical complex exists in the city. Other important iron and steel centers of the Urals include Serov, Nizhnyaya Salda, Alapayevsk, Sverdlovsk, Ufalai, Zlatoust, Urazovka, Asha, Lysva, and Beloretsk. The importance of the Urals-Kuznetsk Combine has declined since World War II with the development of the Karaganda coal fields, which lie closer to the Urals, and the mining of iron ore locally in the Kuznetsk area.

Kuznetsk Basin. Novokuznetsk in the Kuznetsk Basin is the most important iron and steel center in Siberia. The plant is oriented to a large deposit of coking coal. Originally the iron ore was secured from the Urals as a part of an official exchange of raw materials in the Urals-Kuznetsk Combine. Since World War II large deposits of iron ore have been developed south of Novokuznetsk. Limestone deposits are found in the immediate vicinity of the plant. A complete metallurgical complex exists in the area, and a large chemical industry based on the by-products of the coking process is also here.

Central District. In this region blast furnaces are concentrated at Tula and Lipetsk. The precise location of the plants has been determined by the availability of iron ore deposits. Their regional existence is due to the large market for iron in the Moscow-Gorkiy area. The plants primarily produce foundry cast iron. This specialization in a particular product is because of the demand for foundry iron for such products as piping and because the iron ore has too high a percentage of silica and aluminum oxide to produce a good quality steel.

Within the region, Moscow, Elektrostal, and Vyksa are noted for the production of steel directly from scrap. Because many metal fabricating plants are present in the area, a large amount of scrap metal is available. This scrap is fed directly into open-hearth furnaces to produce steel. A major characteristic of the region is the large percentage of steel produced in relation to pig iron output. This region is likely to remain a small center of production, concentrating on specialty products.

Other centers. Since World War II there have been attempts to decentralize the Soviet iron and steel industry. Although this has not been highly successful, isolated new centers of production have developed. The increase in output in certain of the republics is significant. For example, steel production in the Georgian SSR rose from 400 tons in 1945 to about 500,000 tons by 1960; in Azerbaijan during the same period it rose from 23,300 tons to 400,000.

All five-year plans since World War II have provided for high rates of growth in the iron and steel industry. For example, in the sixth five-year plan, it was planned to increase the iron and steel production by one and a half times. New plants are being built, such as the Cherepovets iron and steel plant at Leningrad and the Orsk-Khalilovo iron and steel combine in the Urals, as part of the expansion projects. The Karaganda plant is now in operation and several other new plants are being developed in Siberia (72).

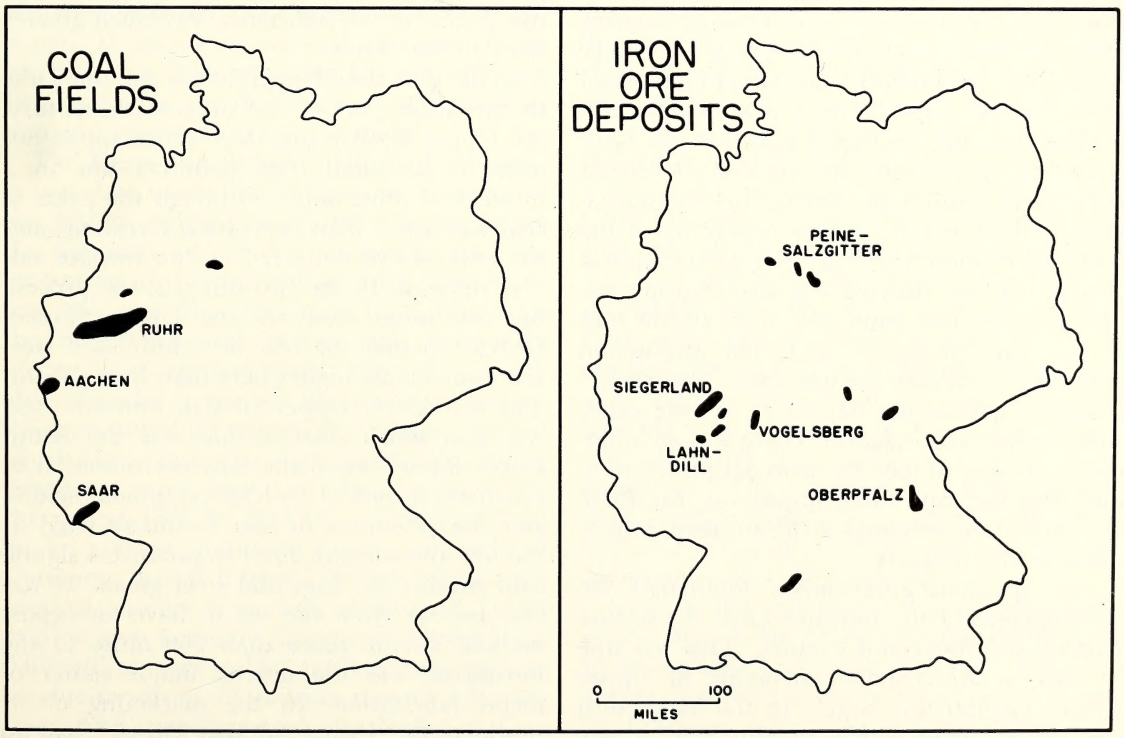
GERMANY

Early distribution of production. As in other countries, the early iron industry of Germany was dependent on local fuels and raw materials, and its distribution largely conformed to the availability of timber and ore supplies. The eighteenth century pattern persisted well into the nineteenth century. At this time three general regions of concentration were recognized (57).

Siegerland and Westerwald. The Siegerland and Westerwald area lying east of the Rhine had possibly one-third of the German blast furnaces in the 1840's. This concentration was due largely to the availability of high quality local ores. There were as many as 650 to 700 mines, each producing a few hundred tons of ore annually during the 1850's. Most of the mines were technically backward, and the cost of mining the ore was relatively expensive. During the early period of development charcoal was the primary fuel, but later the works lying close to the Rhine used coal, first for puddling and later for smelting. The coal came mostly from the Ruhr, but some also came from the Saar (Map 7.11).

In 1865 there were 35 active blast furnaces remaining in the Sieger area, producing about 170,000 tons of iron. Production from the Siegerland grew slowly, but in the Westerwald area it gradually declined in the nineteenth century. The survival of output in Siegerland is attributed mainly to the quality of ore and skill of labor in the district. The ore, containing a high percentage of manganese, yielded a quality pig iron highly desired in the manufacture of steel. Throughout the nineteenth century this region continued to be vigorous, though producing a steadily diminishing proportion of the German output.

Central Germany. The iron industry at the beginning of the nineteenth century was widely dispersed through the small states of central Germany. Forests and ore deposits were abundant so that each state developed a primitive industry that was protected by both their distance from more progressive centers and by the anarchic policies of the states. As the century progressed, however, most of these



7.11. Germany—Coal and Iron Ore Deposits.

advantages disappeared with the growth of a uniform customs union, the Zollverein, and the building of railroads offered competition from the lower-cost producing regions.

Only the most favored areas continued to produce iron in the second half of the century. In 1851 a puddling works was established between Amberg and Sulzburg in the Upper Palatinate in an area long famous for its charcoal-iron industry. In 1869 a steelworks was built at Unterwellenborn in Thuringia. The early success of these plants was due primarily to efficiency in organization. Their survival to the present day is due to the use of the Thomas-Gilchrist process, which permitted the use of the phosphoric ores of Bavaria and Thuringia.

On the North German Plain ores continued to be smelted in the Hanover-Brunswick district. In 1856 the industry was founded at Osnabrück and two years later the Ilseder Hutte plant was built. These plants first produced iron for the puddling works in the Ruhr, but in the 1880's provided the basis for the production of basic steel.

Upper Silesia. In the early eighteenth century charcoal furnaces and refining hearths were scattered through the forests of Upper Silesia. In 1786 Frederick the Great established state furnaces and a foundry at Malopone. His purpose was the casting of guns for the Prussian army as close to the Austrian border as possible to reduce the distance of transportation in time of war. By the beginning of the nineteenth century a small industrial area was thriving in the district. Pig iron output was about 20,000 tons annually, with 10,000 tons of bar iron produced, and coal production amounted to about 200,000 tons. This region possessed advantages denied to all the other iron districts of Germany. There was an abundance of coal, timber for charcoal production, and iron ore; and more important, the Prussian monarchy recognized the strategic importance of the industry.

The Prussian government dominated the development of the industry until the second half of the nineteenth century. This was due in part to the economic structure of Upper Silesia. Capital was largely in the hands of a few great landowners who also held a monopoly on coal mining. These landowners had little interest in producing more iron than could be used on their estates. Finally in the second half of the nineteenth century the capital investment needed to develop a modern iron and steel works, together with its business organization and management, proved too difficult for the feudal landowners, and modern joint-stock companies began to develop.

The modern industry localized in the coking coal region within a triangular shaped area bounded by Gliwice, Beuthen, and Myslowice. This is an area of about 60 square miles. Although the metallurgical industry was coal oriented, the quality of the coal presented some problems. In general the volatile constituent was too high, and the resulting coke was soft and unduly porous. This kept the blast furnaces relatively small. Although the early furnaces used local ores, by the 1860's local ore production was no longer sufficient and imported ores were needed. Ore was first obtained from Hungary, Austria, and Spain, but by the end of the century Sweden came to be the major source. At this time the Upper Silesian area produced only about 45 per cent of its ore requirements. However, this degree of self-sufficiency was much greater than in the Ruhr.

In the growth of Upper Silesia and the Ruhr in the latter part of the nineteenth century, the Upper Silesian area was handicapped not only by its small coal resources but in a number of other ways. Although the price of coal was lower than in western Germany, and the cost of ore delivered at the furnace not very different in the two districts, the processing was more costly in the Upper Silesian District so that the cost of semifinished steel was appreciably higher here than in the Ruhr. The market for Upper Silesian iron and steel was also much smaller than for the Ruhr. Upper Silesia lay in the far eastern section of Germany in one of its least populous regions, and the peasantry of east Germany lived at too low an economic level to produce a significant market for iron and steel goods. It was also too far from the sea to have an export market. Berlin, more than 300 miles to the northwest, was the nearest major center of metal fabrication. In the marketing of its products the Upper Silesian District had to depend almost entirely on railroads, while the

Ruhr had the advantage of the Rhine from the beginning, as well as a well-developed canal system at a later date. It was only in 1895 that a canal from the Oder River reached the industrial area of Upper Silesia.

By the end of the nineteenth century Upper Silesia had developed a small but thriving iron and steel industry. Most of the metal was fabricated locally. The industry was highly integrated with blast furnaces, steel works and fabricating plants. A vertical structure was developed early in Upper Silesia since the great landowners possessed most of the raw materials and the need for the establishment of fabricating works that could absorb the locally produced crude steel.

Evolution of the industry in the Ruhr. Until the 1860's the Ruhr was of small importance in the German iron industry. Other areas in Germany were better supplied with both iron ore and charcoal resources for local iron industries. The ascendancy of the Ruhr is attributed to the introduction of the superior Bessemer furnace in Germany in 1861. Since this furnace required coke for smelting the iron ores, coal became of immediate importance in localizing the iron and steel industry. It was soon realized that the Ruhr with its vast coal resources had the greatest advantages for the development of a modern iron and steel industry in Germany.

The Ruhr also possessed other advantages. It was close to the Ruhr River, a tributary of the Rhine, giving it water transportation for the assembly of its raw materials and the marketing of the finished product. The Ruhr was also near the developed iron district of the Siegerland and Westerwald, and technicians and entrepreneurs were thus available. Finally, it was in the midst of one of the most populous regions of Europe, a region which also possessed a high standard of living requiring many iron and steel products. In the period 1850 to 1913 the Ruhr developed as the greatest industrial region, not only of Germany, but of Europe. In this period coal production rose from 1.66 million to 114.53 million tons annually. Coke output rose from 0.07 million tons to 25.1 million and pig iron production from .01 million tons to 9.20 million. The dominance of the Ruhr in Germany's iron and steel industry has persisted, with the area producing 80 per cent of Germany's coal, 90 per cent of its coke and over 80 per cent of its iron and steel.

Raw materials sources. The bituminous coal reserves of the Ruhr constitute 90 per cent of the German deposits, and may equal the combined total of all other coal fields of continental Europe excluding the Soviet Union (Map 7.11). The area under exploitation has proven commercial reserves to a depth of less than 4,000 feet, which should last for about 250 years at present rate of consumption. The coal deposits aggregate 250 feet in thickness and cover an area approximately 40 miles long, with a maximum width of ten miles. In the south, the limits of the coal fields are irregular, but sharply defined. In the north, east, and west the coal fields dip downward and the outer limits are still undetermined. At present most of the coal mines are less than 1,000 feet deep. Because the iron and steel industry dominates the consumption of the coal mined, emphasis has been placed on mining coking coals. As a result activity has gradually moved northward as the shallow seams are exhausted. Coking coal, with about 42 per cent of the reserves, provides about two-thirds of the total production. There are today about 70 coal mines in the Ruhr, most of them with batteries of coke ovens. In addition coke ovens are also directly associated with the iron and steel works in this region.

The early iron industry of the Ruhr was based on local deposits of bog iron ore. However, with the development of a large iron and steel industry in the 1850's these deposits soon proved inadequate. Other iron ores within Germany were soon sought to satisfy the growing Ruhr industry. First to acquire importance were the iron deposits of the Sieg, Lahn, and Dill districts lying east of the Rhine. These ores are fairly high grade and also contain manganese. They therefore produce a quality steel. Surface deposits are largely exhausted, but underground mining resources are still adequate to last for many years.

Late in the nineteenth century, the phosphoric ores of the North German Plain began to be exploited. Because these ores were low grade, they were costly to transport. The ores of Lorraine were also utilized after 1880. Since eastern Lorraine was then part of Ger-

many, it remained an important source until World War I.

Although there are many iron ore deposits in Germany, all have a fairly low iron content. Consequently, the Ruhr from an early date had to depend on foreign sources. The ore deposits of northern Spain were the first to acquire importance to Germany, with the initial shipment arriving in 1875. These deposits, lying on the north coast of Spain near Bilbao and Santander, had a fairly high metal content and were free of phosphorous. They could thus be utilized in the Bessemer and open-hearth furnaces. With the invention of the Thomas-Gilchrist furnaces in 1878 the Germans were free to use not only local ores but also imported ores that were high in phosphorous. For example, the high-phosphorous Lorraine ores were now utilized in the Ruhr. Swedish ores also became important, and since the 1880's Germany has relied heavily on this source. Swedish ores are primarily magnetite, with an iron content of some 60 per cent. In recent years between 70 and 80 per cent of the Swedish ore export is shipped to Germany, and of this amount between 80 and 90 per cent goes to the Ruhr area.

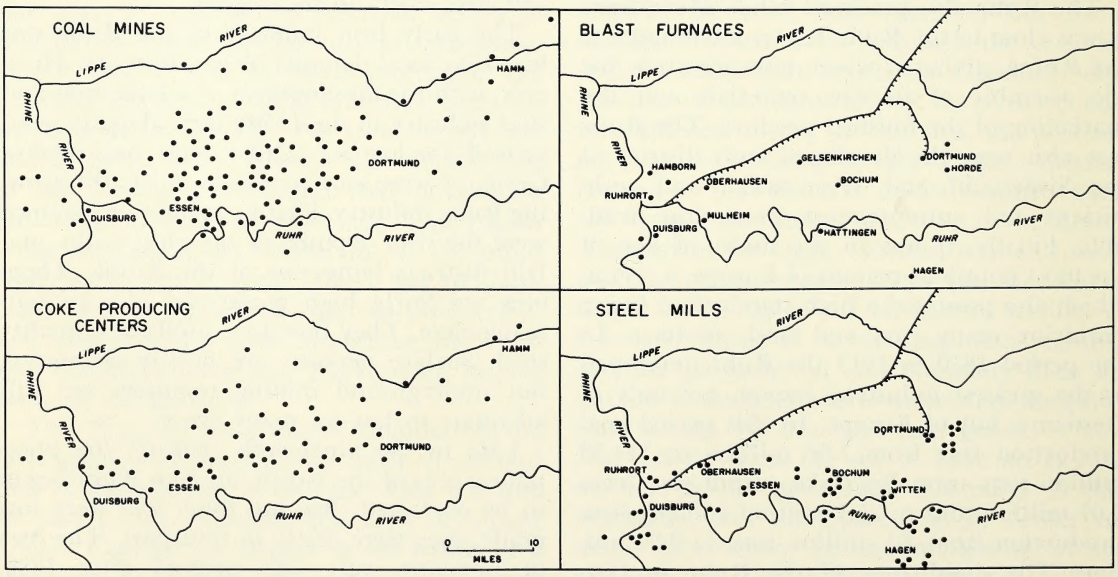
In the 1950's Germany developed domestic iron ore resources and is now capable of supplying 20 to 30 per cent of its total needs. Sweden supplies about two-thirds of the ore required, and the remainder comes largely from northern Spain, Morocco, Algeria, Italy, and the Lorraine deposits of France.

The other resources of the Ruhr iron and steel industry are obtained locally or nearby. Water, a basic necessity for heavy industry, comes chiefly from the Ruhr. The limestone for flux in the furnaces comes from the hill country south of the Ruhr.

Location of blast furnaces. Because most of the iron ores reach the Ruhr region by the Rhine water route, the blast furnaces are primarily located in relation to this traffic. The geographical distribution of the blast furnaces has changed little since 1900. At present three distinct districts of ore smelting exist (Map 7.12).

The Western District centers on the Duisburg-Ruhrort area. There are eight establishments located in the district. All are situated on waterways and have docks equipped to handle ore, limestone, and coal. These works are designed to use Swedish ores and coke from the central Ruhr. This district enjoys a price advantage in the assembly of raw materials, and will continue to be the primary blast furnace area.

The Central District is the smallest of the



7.12. Germany—Ruhr Region.

three blast furnace areas for it is least well served by water transportation. The Bochum and Hattingen plants use ores transported by rail, and coke from neighboring cokeries. A number of the plants produce only pig iron and specialty high quality types of iron such as castings.

The Eastern District centering on Dortmund is supplied with ore in part by canal and in part by railroad. The Dortmund-Ems canal connects with the port of Emden and also, by way of the Aller River, with Bremen. Much Swedish ore is used as well as ore from the North German Plain and Lorraine. By-product coke plants have been developed in the area, with many of them being directly at the blast furnace sites.

Location of the steel industry. The distribution of the steel industry in the Ruhr has undergone considerable change in the twentieth century. During the developmental period, and until 1913, the integration of the industry was one of its outstanding characteristics. This integration necessitated the combination, within a single plant, of the blast furnaces, steel works and rolling industries. This process was particularly adapted to the use of the Bessemer converter and at the time when over half the steel was produced in the converter, integration was widely adopted (Map 7.12).

However, a number of factors have occurred which permit the steel works to be much more widely distributed than the blast furnaces. First with the development of an iron and steel industry in German Lorraine before World War I, much pig iron was imported from this source. Scrap also became a major raw material for the steel industry. This encouraged the development of the open-hearth furnaces which use scrap and pig iron and are not blast furnace oriented. As a result the Bessemer furnace has declined in importance and the Siemens-Martin open-hearth furnace has increased in importance. This type of open-hearth is a regenerative furnace in which the pig iron and scrap are melted and the chemical changes accompanied by burning gases in the chamber itself. Because the demand for gas is heavy the process was little used until both blast furnace and coke oven gas became plentiful after World War I. The blast furnaces and coking plant gases accruing to one ironworks meet not only the requirements of the works themselves, but produce a huge excess as well. With the completion of a gas pipeline network and with the abundance and cheapness of blast furnace and coke oven gases there is no longer the need for completely integrated plants. Consequently, the steel plants are not limited to localization within the blast furnace areas. There are more than twice as many steel works as blast furnace centers.

The distribution of the steel works is strongly influenced by transportation facilities and availability of coke oven gas. The Bessemer converters, which take a molten charge, are found associated with the blast furnaces of Duisburg-Ruhrort district in the western section. However, the Western District produces about two-thirds of the iron and only a little more than 40 per cent of the steel. The excess pig iron is shipped from the west to the steel works in the central and eastern districts. The Central District of Essen, Bochum, Hattingen, and Gelsenkirchen produces about 15 per cent of the Ruhr's pig iron, but more than one-third of its steel. The Eastern District of Dortmund, Witten, and Haspe produces about one-fifth of the pig iron and one-fourth the steel of the Ruhr.

UNITED KINGDOM

Iron ore has been smelted in Great Britain for centuries. Many references are available on the working of iron by the Romans. Because small iron ore deposits were widely scattered and charcoal was available from the forests, the iron industry was also widely dispersed. In the eighteenth century with the depletion of small local forests, the iron industry gradually centralized in major forest areas that also possessed fairly large iron ore deposits. Two of the largest iron producing areas between 1700 and 1750 were the Forest of Dean and the Weald of Sussex and Kent.

Factors affecting the rise of the modern iron and steel industry. The modern British industry dates from the 1730's with the introduction of the means of coking coal. Gradually larger coke-using furnaces replaced the smaller charcoal furnaces. By 1788 nearly half the

British furnaces had converted to coke, and by 1806 only 11 charcoal furnaces remained. In the later part of the eighteenth century, the demands for iron grew rapidly. About 1795 the perfection of the steam engine by James Watt started a chain reaction in the iron industry. To build a steam engine much iron was needed, and increased iron production encouraged the development of larger engines for blowing the furnaces and for operating the machinery of the coal mines. This stimulated the demand for more coal for smelting. With greater supplies of iron available there followed a rapid increase in the number and variety of ways of utilizing the metal.

During the nineteenth century the British industry had technical superiority. Many advancements in iron and steel manufacturing were introduced, such as perfecting the puddling furnace and the use of rollers rather than hammers for drawing out the iron in bars. In the second half of the nineteenth century the major change involved the substitution of steel for wrought iron. Although the first furnace to produce crucible steel was invented in 1742, it was costly to operate, and as late as 1855 only about 50,000 tons of steel were produced in Britain. The growth of the modern steel industry dates from 1856 when the Bessemer converter was introduced. By using this process much larger quantities of steel could be made in a shorter time at considerably lower costs. Shortly after the Bessemer converter was developed, William Siemens in 1861 patented the open-hearth type of regenerative gas-fired furnace for steelmaking.

The introduction of these furnaces was relatively slow for several reasons. Until the 1880's there was an enormous demand for iron, particularly in ship construction. The iron puddling furnaces were efficient and provided a product that was in demand. Finally, both the open-hearth and Bessemer furnaces required a nonphosphorous ore which was found only in Cumberland and North Lancashire and only in relatively small deposits. These furnaces were thus largely dependent on imported ores, primarily from northern Spain.

As the demand for steel gradually increased there was the need for a steel furnace that could utilize the phosphorous ores of the Cleveland Hills and the Midlands. Finally in 1878, the Thomas-Gilchrist basic process furnace was invented. However, this process required special furnace linings entailing the payment of high royalty charges, which resulted in higher costs. Consequently, it was cheaper to import foreign ores in many of the iron and steel districts than to utilize local ores. As a result all three types of furnaces were used in the United Kingdom, their location depending on the cost of iron ore at a particular point.

Production and locational trends. In the nineteenth century the United Kingdom occupied an outstanding position in the world's production of iron and steel. In 1850 the pig iron output was about 2,500,000 tons, or about half the world's supply. Most of the production came from three areas; the Scottish Lowlands, South Wales, and South Staffordshire. At this time the iron industry was almost entirely coal oriented, since the iron ore came from the coal deposits.

Shortly after 1850, as the coal-deposit iron ores were depleted, the industry became increasingly dependent on iron ores from the Cleveland Hills on the Riding coast and on imported iron ores. New centers of the iron and steel industry grew that were oriented to the ore resources. Pig iron production expanded to over six million tons by 1875 and to a pre-World War I peak of 10,300,000 tons in 1913. Although production in Britain increased, its relative position in the world gradually declined after 1870. In 1890 Britain produced one-third of the world's iron, and by 1913 only one-eighth. The United States, with an iron output of 30,970,000 tons, and Germany, with 16,760,000 tons, greatly surpassed Britain by 1913.

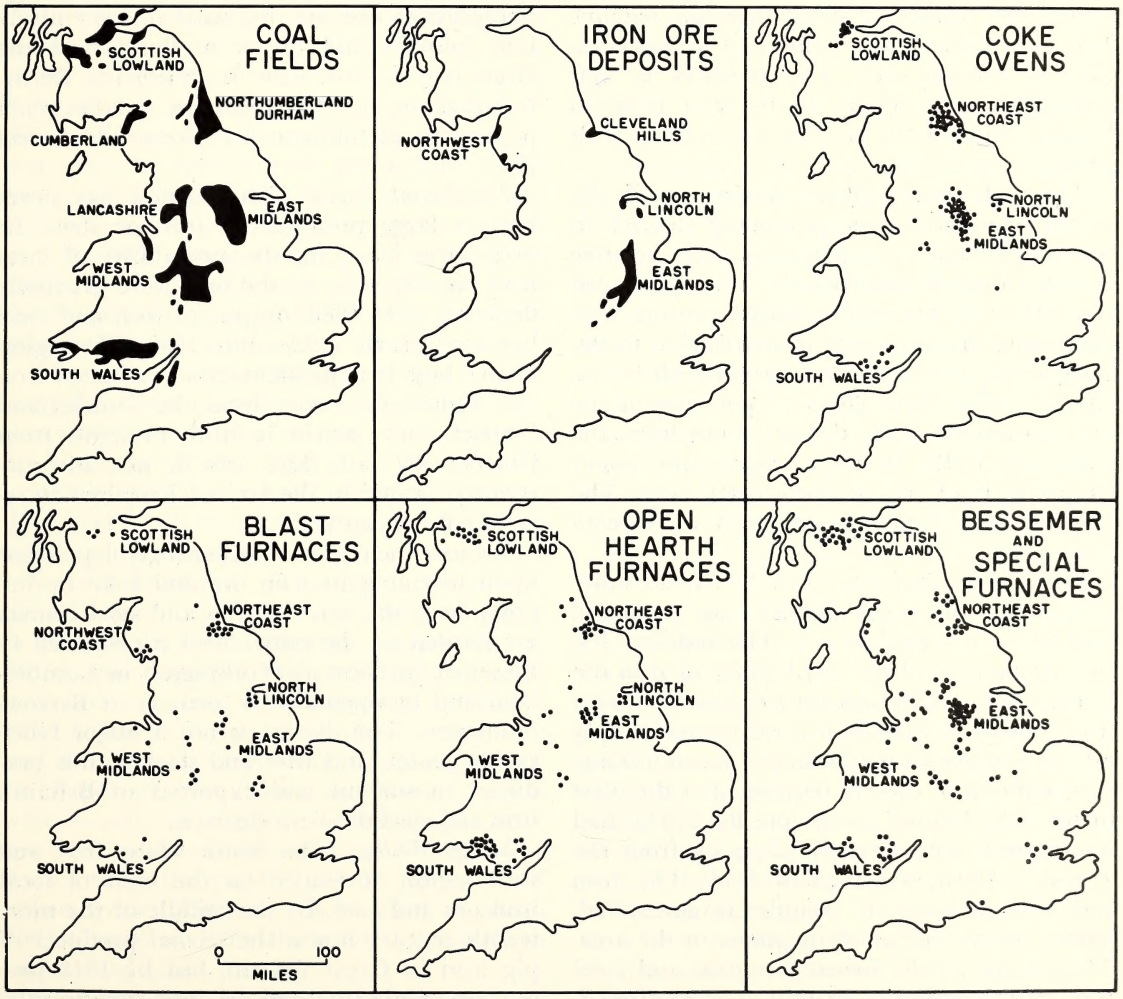
The same trends prevail in the steel industry. Before the introduction of the Thomas-Gilchrist process Britain held a dominant position. However, after 1880 Germany expanded production greatly employing the basic process with Lorraine and other ores, and the United States increased production using the Bessemer and open-hearth processes and consuming Lake Superior ores. Although British output rose from 800,000 tons of steel in 1875 to about six million tons in 1913, Britain was producing only about 10 per cent of the world's steel at this time.

The British iron and steel industry suffered a number of economic crises between the World Wars. Production fluctuated widely, with low levels of output during the economic slump of 1921, the general strike of 1926, and the economic depression of 1931-1933. After a considerable amount of reconstruction and reorganization in the late 1930's the steel industry expanded considerably and in 1939 had an output of over 12 million tons.

The Second World War resulted in a somewhat altered pattern of production, with emphasis once again being placed on use of domestic ores. There was also greater stress on the production of quality alloy steels. Production since 1950 has been steadily expanded, with annual output now between 13,300,000 and 20,200,000 tons. A number of new plants have been built, notably at Margam in South Wales and at Shotton on Deeside.

Iron and steel districts. The United Kingdom has eight iron and steel producing districts. Four of these—Northeast Coast, North Lincolnshire, East Midlands, and Northwest Coast—are located on ore fields. The remaining four—South Wales, West Midlands, Scottish Lowlands, and South Lancashire-North Wales-West Yorkshire—are coal oriented (Map 7.13).

Northeast Coast. The Northeast Coast has been the principal center of iron production in Britain since 1870 (29). Its greatest domi-



7.13. United Kingdom—Coal, Iron Ore, and Metallurgical Regions.

nance occurred about 1912 when it produced 37.7 per cent of the nation's total. The blast furnaces and steel mills are concentrated in the Tees River valley, with the major center at Middlesbrough. The industry localized in the district at the point of greatest transportational advantage for the assemblage of raw materials and the export of its finished products. Large coal reserves lie approximately 25 miles to the north in the Durham field, and iron ore deposits are about 20 miles to the south in the Cleveland Hills. The raw materials are assembled in the Tees Valley, where the greatest network of railroads exists. This area originally provided a tidewater location for exporting iron and steel to other coastal districts of Britain and to foreign markets. This same transportational function remains today, but added to it is the need for importation of foreign ores. The industry is well integrated, with nearly all its blast furnaces having steel plants in close association with them.

Although the Northeast Coast is still the largest iron and steel producing district in Britain, it has experienced a long relative decline. Since World War II it has produced from 23 to 27 per cent of British output. The decreasing importance is primarily due to the gradual depletion of the Cleveland Hills ore. In the 1880's about 80 to 85 per cent of the ore consumed in the district came from the Cleveland Hills. In recent years only about 35 per cent of the ore originates here. The district must depend increasingly on foreign ores.

North Lincolnshire. The North Lincolnshire iron and steel district has expanded rapidly since World War I. The industry has thrived because of the availability of iron ore in the region. Although the ore has the lowest iron content in Britain, it is easily and cheaply mined by open-pit methods, and is self-fluxing. The leanness of the ore requires that the blast furnaces be located on the ore field. The fuel is obtained comparatively close by from the Yorkshire-Derby-Nottingham field. The iron and steel industry is completely integrated. There are no independent plants in the area. This is one of the lowest-cost iron and steel producing districts in Britain. The pig iron is sent to Yorkshire, Lancashire, Staffordshire, and Scotland, and the steel is largely consumed in local engineering industries.

East Midlands. The East Midlands has experienced a rapid expansion in its pig iron production since 1913. It now produces about one-quarter of British output. The industry is located on the Yorkshire-Derby-Nottingham coal fields, and iron ore is obtained from nearby Lucisten and Nottingham. The leading centers of production are Ilkeston in south Derbyshire, Chesterfield in northeast Derbyshire, and Rotherham in south Yorkshire. Most of the seven or eight companies operating blast furnaces own iron mines, and one company has developed a blast furnace center in the iron ore region. This area is largely self-sufficient in its iron ore needs. The high phosphorous ores are processed almost entirely into foundry and pig iron. Because of the large market for iron in Sheffield, Derby, Nottingham, and Northampton, a rather small percentage of the iron is converted into steel (9).

Northwest Coast. This region has never been a large producer of iron or steel. Its origin was based on the availability of local iron ore deposits. As the ores were gradually depleted after 1880, output of iron and steel has been nearly stable since 1900. The region is now largely dependent upon imported iron ore. Some coke comes from the Cumberland District, but much is also brought from Durham by rail. The area is not advantageously located in the United Kingdom to receive coke cheaply.

Because the region is increasingly dependent upon receiving its iron ore and coke by imports from the sea, the iron and steel centers are located on the coast. Steel is produced in Bessemer furnaces at Workington in Cumberland and by open-hearth furnaces at Barrow-in-Furness. The district is not a major fabricating center, and iron and steel is thus produced in surplus and exported to Britain's iron and steel-deficient districts.

South Wales. The South Wales iron and steel region developed on the basis of local iron ore and coal. By the middle of the nineteenth century it was the second producer of pig iron in Great Britain, but by 1913 production of pig iron had declined significantly. The decline in pig iron output is directly

related to the depletion of the coal-deposit iron ore.

Although pig iron production has decreased, the region produces the same quantity of steel as the Northeast Coast. The area is supplied with pig iron from the Northeast and Northwest coasts. Because the pig iron arrives by sea, the steel industry is oriented to the coast. Large quantities of scrap are used with the pig iron in the steel furnaces. Originally the iron industry was oriented to the coal fields, but these interior blast furnaces are not well situated to receive iron ore from Northampton or from imports. All blast furnaces are now associated with steel works, whether they are on the coast or on the coal fields.

West Midlands. This was one of the first heavy metallurgical centers of Britain, with the industry centering on Birmingham. The origin of the industry is traced to the availability of rich coal and iron ore seams, and in the middle of the nineteenth century it held first place in British iron production. With the gradual depletion of local resources, the region declined to sixth place in output of iron by 1913, and to eighth place in the early 1960's. Because of the huge piles of waste from the mines and blast furnaces, this area has gained the unenviable name, "Black Country."

Since World War I the region has emphasized the production of steel, and steel production now exceeds that of iron. This trend is made possible by the large quantities of scrap available from the metal fabrication plants. The steel is produced almost entirely by the basic open-hearth process.

Scottish Lowlands. This region was one of the earliest centers of iron and steel production in Britain. In the nineteenth century the industry was based on the availability of local iron ores and coal (18). However, by World War I the local ores were nearly exhausted and the region became increasingly dependent on imported ores. Since the blast furnaces were located on interior coal fields, they were not well situated for receiving foreign ores. As a result, the production of pig iron declined from 1,370,000 tons in 1913 to about 500,000 tons in 1937, the level that has been maintained since then.

In contrast to the decline in pig iron, the production of steel has increased modestly from 1,370,000 tons in 1913 to about 1,750,000 tons at present. The availability of coal and a local market has maintained the steel industry. Pig iron is imported chiefly from the Northeast and Northwest coasts. The iron and steel industry, integrated only to a limited degree, is located primarily in the neighborhood of Motherwell, Wishaw, and Glasgow in the western portion of the Lowlands.

South Lancashire, North Wales, and West Yorkshire. This is one of the smaller iron and steel producing regions of Britain. Its existence is based on small deposits of coal, and blast furnaces are coal oriented. The iron ore is obtained from the western Pennines. Although the iron and steel industry of this region is one of the oldest in Great Britain, it has always been an area of limited importance.

FRANCE

Localization in the nineteenth century. In the nineteenth century the iron and steel industry of France experienced four locational changes, each caused by a change in raw material utilization. Until about 1840 the French industry was widely dispersed. For example, in 1827 there were 424 active furnaces scattered in 45 departments. However, the most important centers of production were Moselle, Champagne, Le Centre, and the North. The scattered deposits of iron ore and timber resources perpetuated the ancient pattern of production into the nineteenth century.

After 1840 coal was gradually substituted for charcoal and the iron and steel industry migrated to the numerous small coal fields of France. The frequent association of iron ore with the coal deposits added to the importance of the local raw materials. During this period, the building of railroads and extension of the canal system aided in the assembly of raw materials at desired centers, facilitating the marketing of the finished products. Major centers of development in this period were at St. Étienne and Le Creusot.

The third change in location occurred with the introduction of the acid process of steelmaking—Bessemer and open-hearth—from England about 1860. Because there was a shortage of nonphosphorous ores in France

that could be utilized in these furnaces it became necessary to import most of the ores. The sources of the desired ores were Sweden, northern Spain, Cumberland, French North Africa, and Elba. As a result, furnaces were built on or near the coast to process the ore at the point of entry into the country. Coal was also imported in significant quantities, since France possesses little coking coal. In northern France iron and steel centers were developed at Boulogne, Outreau, Isbergues, and Calais. The south of France was the scene of similar developments with blast furnaces at Marseilles, Etang de Thau, and Beaucaire. These coastal iron and steel centers remained important long after the introduction of the Thomas-Gilchrist basic process of making steel from Lorraine ores. The reason lies in the demand for acid steel which has certain unique qualities. However, gradually the demand for acid steel declined as the quantity of cheaper basic steel increased.

The fourth change in the location of the steel industry was inaugurated with the invention of the Thomas-Gilchrist basic furnace in 1878 which could utilize the high phosphorous Lorraine ores for the first time in the production of steel. The localization of the French iron and steel industry on the ore field advanced rapidly and after about 1885 the small centers of production disappeared leaving only the rather larger nuclei, such as St. Étienne, Montluçon, Alais, and Le Creusot.

Modern pattern of production. Lorraine in eastern France is the nation's major metallurgical center. In recent years, this region has produced about 96 per cent of French iron ore, nearly 80 per cent of its pig iron, about 70 per cent of its steel, and nearly two-thirds of the finished iron and steel products. Two other regions are of importance in French iron and steel production. These are the North District with the industry focusing in the cities of Valenciennes, Anzin, and the Central District, with iron and steel establishments at St. Étienne and Le Creusot.

Lorraine Region

Physical basis of the metallurgical industries. The metallurgical industry of Lorraine rests on the physical foundation of enormous deposits of local iron ore and the availability of some coal (50). The Lorraine Minette ore deposit is one of the largest in the world. It outcrops in the escarpment facing the Moselle Valley and extends from Nancy in the south to Longwy in the north, a distance of more than 60 miles. The Lorraine ore is an oxide of iron hydroxide, often of oolitic structure. From the industrial viewpoint, the low iron content of the ore is now its greatest handicap. The metallic content varies from 31 to 38 per cent, and contains 2 to 7 per cent phosphorous. In the western portion of the ore basins there is a predominance of limestone gangue and the ore is self-fluxing. Reserves are estimated at 6,640,000,000 tons, sufficient for many decades of production.

Coal is found in the Moselle Department of Lorraine as a prolongation of the Saar Basin into French territory. The coal is bituminous in nature but until recently was considered noncoking in quality. The beds dip to the west with most mines in Lorraine varying in depth from 900 to 1,800 feet. Because of thin seams, high underground temperatures, presence of water under pressure, great depths and abundance of faults, mining has been difficult. Reserves are estimated at five billion tons to a depth of 4,500 feet. This represents half the total French coal reserves.

Origin of the industry. The availability of widespread local iron ore deposits and wood for the making of charcoal was the primary incentive to the early growth of the Lorraine iron industry. By the end of the eighteenth century more than 50 small furnaces were found in Lorraine with the concentration in the eastern portion of the area. Gradually in the nineteenth century, with the depletion of local bog iron deposits and the growing demand for greater production, the iron industry concentrated in the Moselle Valley where the Minette iron ore outcropped.

The production of Lorraine iron ore increased from about 110,000 tons in 1850 to 1,697,000 tons in 1869. At the time of the Franco-Prussian War of 1870 Lorraine was producing one-third of France's iron output. Because Lorraine iron could not be used in the making of steel, the steel industry was still in its infancy, with Lorraine's output

being less than 10 per cent of the French total.

With the conclusion of the Treaty of Frankfurt in 1871, Lorraine was divided between France and Germany. The western portion, remaining in France, became the Department of Meurthe-et-Moselle, and the eastern portion, annexed by Germany, became the Department of Moselle. There is strong evidence that the Lorraine iron ore deposits were of little or no consideration in the demarcation of the political boundary. The Germans were aware of the existence of Lorraine ore, since German ironworks in the Saar were receiving iron ore from Lorraine at this time. Official French statistics of Lorraine iron ore production were also readily available to the Germans. The Franco-German border was drawn so that France kept the entire ore Basin of Nancy and a large portion of the intensively developed northern ore Basin of Longwy. A minor westward shift of the boundary would have given the entire ore deposit of Lorraine, as well as the developed iron industry, to Germany. During this period the German iron industry in the Ruhr was being rapidly converted to a steel industry, and the high phosphorous ores of Lorraine were of little interest to the German industrialists.

Period of partition 1878-1918. The invention in 1878 of the Thomas-Gilchrist basic process for making steel gave a major impetus to the utilization of Lorraine ore. By using this process it was possible to produce steel from the high phosphorous iron ores. As a result, a rapid expansion of the iron and steel industry occurred in both the French and German portions of Lorraine.

The iron ore deposit of French Lorraine was extensively developed after 1880. Production increased from about one million tons annually in 1880 to 19,629,000 in 1913. Although Lorraine produced about one-third of France's iron ore prior to 1878, by World War I French Lorraine was producing between 80 and 83 per cent of the nation's total. Output of pig iron rose correspondingly from 300,000 tons in 1880 to 3,492,000 in 1913. The steel industry also grew rapidly, with production rising from less than 100,000 tons in 1880 to 2,298,000 tons in 1913. The French Lorraine iron and steel industry developed primarily in the district of Pont-à-Mousson in the south and Longwy in the north. Many French iron and steel companies transferred their activities from northern and central France to Lorraine after 1880. Since French Lorraine possessed no coal, the area was completely dependent on outside fuel. In 1913 approximately 4,074,000 tons of coke were consumed, of which 40 per cent came from northern France and 55 per cent from Germany.

The iron and steel industry of German-occupied Lorraine also grew rapidly after 1878. Iron ore production rose from less than two million tons in 1880 to 21 million tons in 1913. Of the iron ore mined in German Lorraine in 1913, 11,200,000 tons were smelted locally. German Lorraine in 1913 produced 3,900,000 tons of pig iron and 2,286,000 tons of steel. This was about 22 per cent of the pig iron and 13 per cent of the steel output of Germany. During this period a system of exchange was established between Lorraine and the Ruhr, with iron ore and pig iron moving eastward into Germany and coal and coke moving westward into Lorraine. In 1913 German Lorraine produced 3,800,000 tons of coal but consumed 11 million tons. Dependence on coke from outside Lorraine was even greater, with 4,800,000 tons out of the 4,900,000 tons consumed coming from the Ruhr.

In German Lorraine the iron and steel industry was centered in the Thionville District, with plants at Audun-le-Tiche, Redange, Knutange, Uckange, and Rombas. Prior to World War I the German and French sections of Lorraine developed essentially as distinct units. Only one French company, de Wendel, had plants at Moyeuvre and Hayange in Moselle and also a major plant at Joeuf in Meurthe-et-Moselle. In the development of German Lorraine and the Ruhr, the Germans gave preference to the Ruhr, particularly in the establishment of steel-making facilities. This was due to the availability of coke in the Ruhr. In addition, German Lorraine, situated on the border in a contested area, was always considered to have an exposed geographical position.

Lorraine between world wars. At the conclusion of World War I France reacquired the

Department of Moselle from Germany. With this annexation the capacity of the iron and steel industry of France was increased between 40 and 50 per cent. In order to rebuild war-torn France, demand for iron and steel was high, and immediate steps were undertaken to revitalize the iron and steel industry of Lorraine. This expansion program persisted until 1929. Iron ore output rose from less than ten million tons in 1919 to 46,058,000 tons in 1929. Output of iron ore during most of the 1920's far surpassed the needs of the Lorraine iron and steel industry, which consumed only about one-half of the production. About 10 per cent was sent to other French metallurgical centers. The remainder was exported to foreign countries, principally to Belgium and Luxembourg. German importation of French ore rapidly declined, and during the 1920's this nation took only about 6 to 8 per cent of French exports. The Saar, the Netherlands, and the United Kingdom received most of the remainder of the iron ore exports. Although the movement of iron ore eastward into Germany declined greatly, the coal used in the coking ovens of Lorraine came almost entirely from Germany, since this was the major source available to French Lorraine.

Iron and steel producing facilities were greatly increased in Lorraine during the 1920's. Output of iron rose from 2,417,000 tons to a peak of about 7,900,000 tons during the same period. During the 1920's Lorraine produced between 72 and 80 per cent of the iron in France. Steel production likewise rose from 1,383,000 tons in 1920 to 6,550,000 tons in 1929. This was about two-thirds of total French steel output.

With the onset of the world economic depression after 1929, the Lorraine iron and steel industry began a long period of decline. At the depth of the economic depression in 1932 iron ore output was only 26,180,000 tons, a decline of about 20 million from the 1929 peak. Iron output also declined to 4,360,000 tons and that of steel to 3,786,000 tons; this was only 50 to 60 per cent of the output of the 1920's. The processing of iron ore and iron and steel recovered only moderately during the remainder of the 1930's. In World War II Lorraine was once again controlled by Germany. However, because of war conditions and the briefness of the German occupation there was little or no attempt to integrate the iron and steel industry of the Ruhr and Lorraine. This industry continued to stagnate in Lorraine during the war years and output declined to insignificance.

The Monnet Plan. At the conclusion of World War II, it was recognized by government and industry that French manufacturing had to be revitalized if the nation was to regain a stable economy (50). In 1946 France's economic position was desperate in two respects. There was not only the problem of the destruction of industry by the war, but plant facilities were so old and depleted that France could no longer be considered a major industrial power.

In order to revitalize French industry General de Gaulle organized the "Commissariat Général du Plan de Modernisation de l'Équipement." The plan, however, was implemented under the direction of Jean Monnet and is commonly known as the "Monnet Plan." The primary objective of the Monnet Plan was to expand industrial investment and channel the increase, as much as possible, into six key industries—coal, steel, electric power, cement, agricultural machinery, and transportation—which were basic to the entire economy. Of these industries iron and steel received the greatest attention, since it was recognized that this was the primary industry in modern manufacturing.

The specific objectives of the 1947 plan for the redevelopment of the metallurgical industries were as follows: to restore and modernize the productive capacity, which had remained largely unused since 1931; to adapt the nature of iron and steel production to the demand of the consumer; to reduce the unit consumption of coke in the blast furnaces and to improve the preparation of the iron ore; and to modernize and expand the supplementary installations such as the coke ovens and iron ore mines.

To implement these plans, both public and private investments were sought in ensuing years. Aid from the United States, under such agencies as the Economic Recovery Program, was instrumental in much of the early success of the Monnet Plan. By the end of 1952 the

total expenditure in the metallurgical industries was almost 350 billion francs. About 65 per cent of this amount was devoted directly to the iron and steel industries, the remainder being given to subsidiary industries such as iron ore and coal. Because of its importance, Lorraine has received about 80 per cent of the total metallurgical expenditures under the Monnet Plan. The influence of the state in the development of France's basic industries has been among the most systematic and pervasive of all nonsocialist countries.

The expansion of production in the metallurgical industries has been obtained in a number of ways. To aid the iron and steel industry the Chambre Syndicale de La Sidérurgie has established a Productivity Committee to investigate concrete problems connected with organization, statistical and accounting methods, and plant operations on which labor problems have a particularly important bearing. Similarly, with regard to production and production control the Association Technique of the French iron and steel industry offers guidance on engineering problems. There has also been a reorganization of the iron and steel industry's economic structure. Between 1950 and 1955, mergers reduced the number of French crude steel producers from 24 to 10. It is felt that a higher efficiency of operation has thus been secured.

The modernization plans of the iron and steel industry have attempted to raise the efficiency of operations at all levels of production. Before iron and steel production could be increased, there had to be a rise in iron ore output. As a consequence, all operating mines in Lorraine have been modernized. In underground operations, the use of mechanical loaders and electrical transportation has considerably increased the output per worker. In order to provide greater safety in the mines, a new mode of steel bars for roof support has been inaugurated. As a result of these and other improvements, iron ore production in Lorraine rose rapidly to 28,250,000 tons in 1950 and to over 60 million tons in 1960. The increased production has once again made it possible for France to become a major exporter of iron ore.

There have also been attempts to develop the coal resources of Lorraine. Mines have been modernized and exploitation has extended westward into the deeper seams. Consequently, output of Lorraine coal by 1952 was more than double the pre-World War II peak, and by 1960 annual production was over 25 million tons. Because of increased mechanization, the Lorraine coal mines give the highest yield in Europe per underground shift. Because Lorraine coal was of the noncoking type prior to World War II, a research program was inaugurated in 1947 to discover if this coal could be coked. After seven years of experimentation it was found that by mixing Lorraine coal with others less friable, a good coking coal could be obtained. Although coal from northern France and Germany must still be brought to Lorraine, the metallurgical industries are no longer completely dependent on outside sources of coke. The coking industry has also been greatly expanded. Within the coal region, Carling, the traditional center, and Marienau, a new center, are coke producers. In the metallurgical region six centers produce coke in Meurthe-et-Moselle and three in Moselle. By 1953 yield of coke from Lorraine coal was about 500,000 tons annually, and additional facilities increased the output by the early 1960's to four million tons. Lorraine blast furnaces and steel plants are now largely independent of sources of coke from outside the region.

In the iron and steel industry of Lorraine increased production has been obtained in a number of ways. The most spectacular development occurred at Sollac, near Thionville, where a completely modern integrated steel plant was erected. Less striking but equally important are the attempts to increase efficiency in the older plants. The greater preparation of the ores by crushing and sintering has not only insured a more regular operation of the blast furnaces but has provided a substantial saving of fuel and a reduction in the tonnage of ore consumed per ton of iron produced. There has been a trend toward fewer but larger blast and steel furnaces, which results in greater output with proportionately less labor. There has also been the gradual replacement of old handmills by mechanized semi-continuous or continuous mills that have not only raised

output, but improved the quality of products with no increase in the labor force. In the same way, mechanization in general, increased thermal efficiency, and the rational organization of transport inside the plant have aided productivity. As a result, iron production rose to 6,460,000 tons by 1950 and to 11,000,000 tons in 1960. Steel output reflects the same trend rising to six million tons in 1950 and to 12 million tons in 1960. By 1952 the previous peak of 1929 had been surpassed in the iron and steel industry.

The expansion of the Lorraine iron and steel industry has provided adequate steel not only for domestic industries, but has given France a surplus for export. Within recent years French net exports of finished steel are more than twice as large as those of the United Kingdom or West Germany, and much larger than French net imports of engineering products.

The European Coal and Steel Community. The political splintering of the metallurgical region of Western Europe has created many problems (16). Most present-day European leaders believe that the economic rivalry of Europe is a major cause of conflict. Since World War II, there has been much consideration as to how economic problems of an international nature can be solved. A proposal to attack these problems was made on May 7, 1950 by Robert Schuman, then French foreign minister, who offered to pool French coal and steel production with that of West Germany and any other European country prepared to yield national control to an independent supranational authority. The primary purpose of the Schuman Plan was the fusion of interests and the creation of economic and political solidarity, thus eliminating the age old enmity between France and Germany and making war between the two countries "not only unthinkable, but materially impossible."

After considerable negotiation, six countries —France, West Germany, Belgium, Italy, the Netherlands, and Luxembourg—founded the group now known as the European Coal and Steel Community. The High Authority of the ECSC began its function in August 1952. The fundamental purpose of the Community is the development of a single market through the establishment of conditions which assure the most rational distribution of production at the highest possible level of productivity, while safeguarding employment and avoiding economic disturbances. To initiate the plan, the common market for coal, iron ore, and scrap was established on February 10, 1953, and for steel on May 1, 1953. At this time customs duties, quantitative restrictions on imports and exports, discrimination in transport rates, and dual pricing practices among the countries of the ECSC disappeared in principle. The ECSC is accomplishing the above objectives in three major ways: by gathering and publishing information and organizing consultations; by placing financial means at the disposal of individual enterprises; and by direct control, in accordance with the provisions of the treaty, but only when circumstances make it absolutely necessary.

Although the ECSC was initiated by France with the ultimate objective of European economic integration, France hoped to immediately gain a more significant position for Lorraine in Western Europe, particularly in relation to the Ruhr. For decades the Ruhr has surpassed Lorraine in iron and steel output. This superiority is based partly on the availability of high quality coking coals and partly on its position in the Rhineland, with unexcelled water transportation facilities. In contrast, Lorraine is served essentially by a network of land transportation. Consequently, Lorraine occupies a high-cost position in regard to assembly of coal and the marketing of its finished products.

Lorraine prior to 1952 was also burdened by transport discrimination and excess tariff charges on freight. The ECSC has been successful in abolishing many of these discriminatory charges. For example, between 1952 and May 1957 the cost of shipping a ton of Ruhr coal to Lorraine decreased from 23 French francs to 16. With the electrification of the Thionville-Koblenz railway the rates will be further decreased.

In order to connect Lorraine with the Rhineland's water routes the French stipulated at the establishment of the ECSC that one objective of the plan should be the completion of the Moselle Canal from Thionville to Koblenz. Transport experts have calculated

that the canal would reduce the cost of sending a ton of Ruhr coal to Lorraine by 50 to 60 per cent, and of shipping a ton of rolled steel from Thionville to the world market (through Rotterdam instead of Antwerp) from 23 to less than 8 francs. Such a reduction in freight charges would substantially lower the price of Lorraine steel in the international market. At the same time the proposed canal would make it possible for iron ore to go from France to Germany more cheaply than from any foreign source. As a consequence, Germany would once again be linked to France by Lorraine ore as France has been bound to Germany by its need for Ruhr coal.

Although the iron and steel industry of Lorraine has long favored the building of the canal, much opposition arose. The steel magnates of the Ruhr were adamantly against the plan. Regarding Lorraine as its major competitor, the Ruhr did not favor expanded competition. The Germans have pointedly refrained from the purchase of Lorraine ore to complement the high-grade Swedish ores and low-grade local ores. The railways of both France and Germany opposed the canal, which would deprive them of a profitable business. Even the French steel industry outside Lorraine showed little enthusiasm for the canal, since these areas would remain dependent on high-cost railroad facilities for their raw materials and for shipping finished products.

Nevertheless, the government of France has consistently believed the canal to be fundamentally necessary to the economic welfare of the Lorraine iron and steel industry. As a consequence, on October 27, 1956 Germany signed a treaty to cooperate with France in the construction and financing of the improved water route in return for political and economic sovereignty in the Saar. The construction of the 175-mile Moselle Canal, costing $150 to $180,000,000 and lying almost entirely in German territory, began in the summer of 1957.

The ECSC has made considerable progress in establishing a single market for iron and steel in Western Europe. Nevertheless, there is evidence that problems still exist. Lorraine steelmakers believe that excessive freight rates are charged for the transport of coal from Germany, whereas for iron ore they are artificially low. The French conclude that, through the large outlay on the transport of coal, Lorraine is in reality subsidizing the cheap transport of iron ore on German railroads. It is also believed that the Ruhr continues to give preferential treatment to other German areas. For example, it has been calculated that for a haul of 200 miles the transport of a ton of Ruhr coke would cost 32 shillings if its destination were Lorraine, but only 23 shillings if its terminus were within Germany.

The ECSC has not proved to be a panacea for all existing problems, but progress is being made. The European Coal and Steel Community has laid the foundation for further cooperation, as exemplified by the establishment of the European Community of Atomic Energy and the European Economic Community, both on March 25, 1957. The leaders of the six cooperating European nations hope that from economic union a united Europe will eventually evolve.

Other iron and steel regions. Besides Lorraine, France possesses two other iron and steel producing regions.

The North. The iron and steel industry of the North is localized on the coal fields. The blast furnaces are concentrated at Denain, and most of the iron and steel works are grouped in the Valenciennes-Anzin district. The metallurgical industry has concentrated at the eastern end of the coal field near Belgium in spite of the fact that most metallurgical coke is produced in the west. This localization is largely because of the greater market for engineering products in the textile regions on the Franco-Belgian border. Originally, local iron ore was available, but these deposits have long been exhausted. The region depends entirely on imported iron ore from Lorraine and foreign sources. Consequently there is a greater production of steel than pig iron. The steel industry depends heavily on the local availability of scrap for its production.

Central District. The ancient iron industry of the Central District has survived in a number of centers where coal is still available. The iron and steel industries of Le Creusot and Nevers are based on the coal field of Le Creusot. The Montluçon coal field produces only about 500,000 tons of coal annually,

but provides sufficient fuel for a local metallurgical industry. The iron and steel industry at St. Étienne is also based on local coal deposits. The ores of the Central District are depleted, or are too scattered to be valuable. Because the resource base is weak, and the market relatively small, this area is noted for its production of quality steels. For example, St. Étienne now produces no pig iron, but processes large quantities of imported metal and makes semifinished goods. It not only has basic and acid steel furnaces, but also electric furnaces, drawing the necessary power from local coal and hydroelectric installations. The industry has extended into the Rhone Valley in the Lyons area and into the Ondaine Valley. Lyons is the major metal market for the region.

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CHAPTER EIGHT

ALUMINUM INDUSTRY

Aluminum is the most important commercial light metal. However, compared with steel, copper, lead, or zinc, it is a new metal in the world's economy. Its commercial production dates from 1886 when the Hall-Héroult process was developed to produce aluminum cheaply. Before this date aluminum was a rare metal and more costly than silver. The metal was first discovered in 1825 and its earliest development began when Napoleon III became interested in aluminum to lighten the weight of his military equipment. Since the cost was prohibitive it remained a novelty. For example, in 1855 some of the first metal produced in France was used to make a rattle for the Prince Imperial, and Napoleon presented a watch chain of aluminum to the King of Siam on his visit to Paris.

With the discovery of the electrolytic process for producing aluminum, the metal has been made available in large quantities. Its physical characteristics make it the structural engineering metal most closely competitive with steel. Aluminum is unusually malleable and ductile and may be worked and shaped with comparative ease. It possesses high thermal and electrical conductivity and has a tensile strength of about 13,000 pounds per square inch. By alloying with other metals its tensile strength may be raised as high as 70,000 pounds per square inch. One of its greatest advantages is its low specific gravity—2.7—which is approximately one-third the specific gravity of other common commercial metals.

Possibly no other metal has developed as many diversified uses in so short a time. Markets have expanded so that the industry now has more than 2,000 users. The transportation industries each year consume the largest percentage of aluminum, followed by the electrical, household appliance, and construction industries. Thus, its application ranges from wrist watches, bracelets, beads, and mesh bags to girders, bodies for dump trucks, and moving vans.

RAW MATERIALS OF ALUMINUM

Bauxite

Aluminum is one of the most common minerals in the earth's crust. Approximately 8 per cent of the surface layer of the earth consists of aluminum, about 5 per cent iron, and less than 0.2 per cent copper, lead, and zinc. Aluminum, however, is never found in nature as a metal and remained undiscovered long after man was using other minerals. Although every clay bank and practically all of our common rocks contain aluminum in varying proportions, the metal at present is produced on a commercial scale from only one mineral—bauxite.

Mode of occurrence and mining methods. Bauxite is a hydrated aluminum oxide containing as impurities the oxides of iron, silicon, titanium, and several other elements. In general, bauxite deposits occur in irregular beds of varying thickness. They may be at considerable depth, overlaid with sandstone, limestone, clay, and similar materials.

Bauxite is mined by both open-pit and underground methods. The mining method in any district depends on the relation of the ore to the surface of the ground. When found at or near the surface, open-pit operations prevail because of lower costs. The amount of overburden which can be removed from an ore body depends upon its thickness and the character of rock. Normally the rock is weathered and is easily removed. In Arkansas as much as 110 feet of overburden have been removed to reach 20 feet of bauxite. Stripping, however, is not common if the overburden is more than 50 feet. Although surface stripping offers few technical problems, the erratic nature of bauxite deposits makes the process slow. It may require six months to uncover a deposit of bauxite which can be mined in one month.

In underground mining the "room-and-pillar" method is used. A lower recovery rate results from this method because of the necessity of leaving ore in the mine roof and as pillars to support the roof. From 25 per cent to as much as 50 per cent loss is not unusual in underground mining. Subsurface mining is usually more expensive because of handloading, timbering, pumping, ventilation, and other requisites of working below the surface.

In the United States, open-pit mining prevails in Georgia and Alabama, but in Arkansas and Tennessee both methods are practiced. As the surface deposits are exhausted, subsurface mining is increasing in the United States. In the Guianas and Brazil mining is largely by subsurface methods, and in European countries both surface and subsurface methods are practiced.

Distribution of bauxite deposits. Bauxite is widely distributed, from the equator to approximately 55° north and south latitudes. Rarely are deposits found in the higher middle latitudes or subarctic areas. Bauxite is now mined in 28 countries, and annual world production is around 27,500,000 tons. In recent years seven countries—Jamaica, United States, British Guiana, Surinam, France, Russia, and Hungary—have been producing more than 80 per cent of the world's bauxite output.

United States. The total bauxite production of the United States since 1900 has been second only to that in France. More than 95 per cent of the output has come from Saline and Pulaski counties in central Arkansas. Some bauxite is mined in Georgia and Alabama, but the relative importance of these sources has not increased appreciably despite the intensive development and exploration during the past decade.

Active development of the Arkansas deposits began in 1895 when 20 tons of ore were mined. Production increased to 25,000 tons in 1903 and reached nearly 200,000 tons by 1914. World War I demands resulted in a remarkable increase with a peak production of 500,000 tons in 1918. Output did not exceed this figure until the World War II period. The annual average output in 1930-32 was 206,000 tons and in 1935-38, 340,000 tons. Although domestic output followed an upward trend in the 1930's, its ratio to world production declined from 17 to 11 per cent.

During World War II, the expansion of the domestic bauxite industry was great, especially in view of the limited reserves of high-grade ore. Between 1941-43 the annual output averaged 3,286,000 tons. A peak output of 6,233,000 tons was reached in 1943, after

which production declined as shipping facilities for imported ores improved.

The demand for aluminum in the early postwar period resulted in a reversal of the trend in 1947 and output rose reaching a postwar peak in 1954 when 2,353,000 tons of bauxite were produced. Since then production has varied from 1,400,000 to slightly over two million tons. The decline of United States production is primarily attributable to the accessibility of high-grade ores from Jamaica and other Caribbean sources. The alumina content of domestic ores now being utilized ranges from 47 to 52 per cent. This is appreciably lower than imported ores which contain 50 to 61 per cent alumina. This fact helps explain the rather large dependence on foreign ores.

In November 1941 the U. S. Geological Survey estimated the proved bauxite reserves at 18 million tons of commercial ore, plus 11 million tons of low-grade ore. At the 1935-40 rate of production this would have lasted about 45 years. However, with the increased demands during World War II, the nation's reserve position was soon critical. An intensive exploration program was begun which discovered within three years 38 new bauxite and eight new high-alumina clay deposits in Arkansas alone. Likewise, exploration in central Georgia revealed more than one million tons of commercial grade bauxite. Most of the high-grade alumina clays were discovered in Washington, Oregon, and Idaho. Although most of the surface deposits had been discovered, subsurface exploration was essentially unknown until 1942. The total commercial ore discovered between 1941 and 1944 was about 23,500,000 tons. In addition, over 34 million tons of potentially usable submarginal bauxite and bauxitic clays were located (6).

New discoveries have continued in recent years and in 1960 there were about 50 million tons of commercial bauxite reserves in the United States. However, the reserves of high-alumina materials, exclusive of anorthosite (considered a potential ore) total three billion tons, containing 356 million short tons of recoverable aluminum. A little over 2 per cent is high-iron content bauxite, .15 per cent is alunite, and 95 per cent is low-grade bauxite; bauxitic clays, and high-alumina clays. The United States has small reserves of Grade I bauxite (not more than 7 per cent SiO_2; not more than 3 per cent FeO) which was used exclusively before the war. Recent technological advances have made Grade II ore (not more than 15 per cent SiO_2; not more than 6 per cent FeO; not less than 40 per cent Al_2O_3; and not less than 32 per cent available alumina) commercially available. The nation's aluminum resources in the lower grade bauxites and clays are enormous, but it probably will be cheaper to import high-grade foreign ores than to extract alumina from low-grade domestic material. In recent years about 75 to 80 per cent of the nation's bauxite demands have been imported.

Jamaica. Bauxite was first discovered in Jamaica in 1942. However, the development of the deposits did not begin until the early 1950's when three North American aluminum producers—Kaiser, Reynolds, and Aluminium, Ltd.—began exploitation. The first ore was exported from Jamaica in 1952. Exploitation now occurs in three centers. Reynolds Jamaica Mines Ltd. operates mines in St. Ann Parish, about six miles from the company's port on Ocho Rios Bay. A drying plant near the mines removes most of the free moisture before the ore is carried by aerial tramway to the dock.

The Kaiser Bauxite Company has mines in St. Elizabeth Parish and transports its ore over a 13-mile private railroad to the drying and shipping facilities at Port Kaiser on Little Pedro Point. The Aluminium Ltd. subsidiary, Alumina Jamaica, Ltd., has its mining properties in Manchester Parish near Mandeville. This company originally exported its ore through the docks at Kingston, but in 1954 completed a private port on Old Harbour Bay, known as Port Esquivel, on the south coast. An alumina processing plant, the first in the Caribbean, began production near Mandeville in 1952.

The development of the bauxite deposits in Jamaica has brought the largest single industrial investment to the island. The Jamaican government leases government lands to producers and receives a royalty of one shilling (14 cents) per ton for bauxite removed, as well as an income tax at the rate of four shillings per ton shipped. Since 1953 the gov-

ernment has collected more than $1,000,000 annually. The increase in production has been most striking. In 1952, 382,000 tons of bauxite were produced. From 1954 to 1958 production increased from 2,044,000 to 5,722,000 tons, making Jamaica the largest producer in the world. The United States and Canada import nearly all of the Jamaican bauxite output.

British Guiana. The bauxite deposits of British Guiana occur in the northeastern portion of the country. Production in recent years has varied from 1,500,000 to 2,480,000 tons annually. The largest deposits are along the Demerara and Berbice rivers about 60 to 80 miles from the coast. The ore bodies are flat-lying and the overburden (the rock material on top of ore) ranges from zero to 60 feet. The better grade ore contains about 60 per cent alumina. Between 15 and 20 per cent of the ore mined in recent years is a nonaluminum grade which is exported for use by chemical industries. The known reserves of the area are more than ten million tons of commercial ore. Most of the British Guiana bauxite is exported to Canada.

Surinam. The bauxite deposits located along the Surinam and Cottica rivers are among the largest reserves in the world. The ore bodies lie along the transitional zone between coastal lowlands and interior foothills. The largest mining center is Moengo which is 100 miles by river from the sea, but only 20 miles by air. The thickness of the ore bodies varies from six to 25 feet, and the overburden from zero to 60 feet. Reliable estimates of total reserves have not been published, but the visible reserves at Moengo are ten million tons and those at Rorak on the Surinam River eight million tons. With an output in 1960 of about three million tons, it is estimated ore will be available for about 100 years.

France. France is the leading producer of bauxite in Europe although it ranks third or fourth in reserves. The principal producing districts are near the Mediterranean Coast in the departments of Var and Hérault. More than 75 per cent of the total production of about 1,790,000 tons annually comes from the Var District and three-fourths of the remainder from the Hérault District. France was the world's leading producer of bauxite until the beginning of World War II, but now usually ranks fifth or sixth. The ore content averages 50 to 55 per cent alumina and reserves are estimated to be six million tons.

Hungary. Hungary with an estimated reserve of 250 million tons has one of the largest reserves in the world. The most important mining district is the Vertes Mountain area in northwestern Hungary. Mining is carried on by stripping operations, and reserves in this district are estimated at 120 million tons. Until recently this was the only area of extensive mining, but the Bakony Forest section is now in production. Reserves in this area are estimated to be 130 million tons. Production between 1955 and 1960 varied from 880,000 to 1,240,000 tons annually.

Soviet Union. The Soviet Union, which has developed its bauxite industry since 1935, has a large number of known deposits. The most important deposits exploited are those in the northern Urals known as the Severouralsk group of mines, which include the famous Krasnaya Shapochka deposit. The ores of this deposit have a content of 41 to 48 per cent aluminum, and are probably the highest quality ores in the country. The bauxite reserves of the Ural Mountains are estimated to be over 30 million tons. In northwest Russia two centers of bauxite mining exist at Sokolovskoye and Tikhvin. Other known deposits are in the southern Urals, in the Bashkir Republic, and in the Angara River region near Lake Baikal. Annual production from 1954 to 1960 increased from 1,390,000 to over three million tons.

Other sources. Numerous deposits of bauxite are known in Italy. However, mining has been largely centered in the Istria Peninsula and in the south central Apennine provinces of Abruzzi and Campania. The Istria deposits are most important in both quantity and quality. Production was between 500,000 and 600,000 tons prior to World War II, but in 1959 output was only 287,000 tons. Total reserves are estimated to be 6,300,000 metric tons.

Yugoslavia has extensive deposits of bauxite with workable reserves estimated at 105 million tons. Most of the known deposits are near the Adriatic Coast and associated with karst topography (topography resulting from

the solution of limestone). Annual production in recent years has been about 800,000 tons. Bauxite deposits are also fairly widespread in southern and western Greece with the best deposits north and east of the Gulf of Corinth. The ore is particularly good quality and mining is by open-pit methods. Output in Greece has risen from 492,000 tons in 1954 to 886,000 tons in 1959.

There are more than 80 bauxite deposits in Brazil and reserves are estimated as high as 192 million metric tons. The deposits occur in the states of Minas Gerais, São Paulo, Rio de Janeiro, and Espirito Santo in the southeast and in Pará, Maranhao, and Bahia in the northeast. At the present time most of the production comes from the Poços de Caldas plateau region of southwestern Minas Gerais and adjacent São Paulo, where reserves are estimated to be more than 120 million tons.

In the Caribbean area, Haiti and the Dominican Republic are new centers of production. Commercial shipments of bauxite from Haiti began in April 1957 from a concession near Miragoâne. The ore is mined by stripping and then trucked eight miles to a drying plant at the pier, which is 3,000 feet lower in elevation than the mine. Commercial production from the Dominican Republic began in 1959.

Other important deposits of bauxite are being developed in Austria, Spain, Romania, Indonesia, Guinea, Ghana, Malaya, India, and Sarawak.

Cryolite

Cryolite is a sodium aluminum fluoride, a raw material necessary for dissolving alumina in the electrolytic process. It is found only in Greenland. Because it is difficult and costly to obtain, a synthetic cryolite has been developed and is produced principally in alumina plants. Hydrofluoric acid, soda, and alumina are required materials for its manufacture. These materials are used in so small a quantity they have no influence on the distribution of the reduction plants.

Carbon

Carbon is another raw material used in the production of aluminum. About one-half ton or more of carbon electrodes is consumed in the production of one ton of the metal. A carbon with a low ash content is superior, since any impurities that become mixed with the electrolytic bath impart impurities to the aluminum ingots. Petroleum coke is preferred because of its low ash content. Although the amount of carbon used is large, there is no evidence that it has any influence on the location of reduction plants.

LOCATIONAL FACTORS

Bauxite processing plants. Bauxite normally has a large percentage of foreign materials when mined. These clay impurities are heavy and bulky and are always removed near the mine by a simple crushing and washing process. The ore is then dried in rotary kilns to remove some of the absorbed moisture. The presence of clay in later stages of the refining process results in the loss of materials and reduces the percentage of aluminum recovered. In processing bauxite, the fuel and power requirements constitute an important but never a critical locational factor. When available, natural gas is the fuel preferred for the drying process; but coal and fuel oil are used in many places. Electrical power is used for crushing the ore and for other operations. From 5,000 to 6,000 kilowatt-hours of electrical energy is needed to process one ton of ore.

In the United States washing and drying plants are located near deposits at Bauxite, Arkansas, and elsewhere. The ore from Surinam is washed and dried at plants near Moengo and Paranam on the Cottica and Surinam rivers. In British Guiana crushing and drying are done at Mackenzie at the head of navigation of the Demerara River, a few miles from the ore deposits.

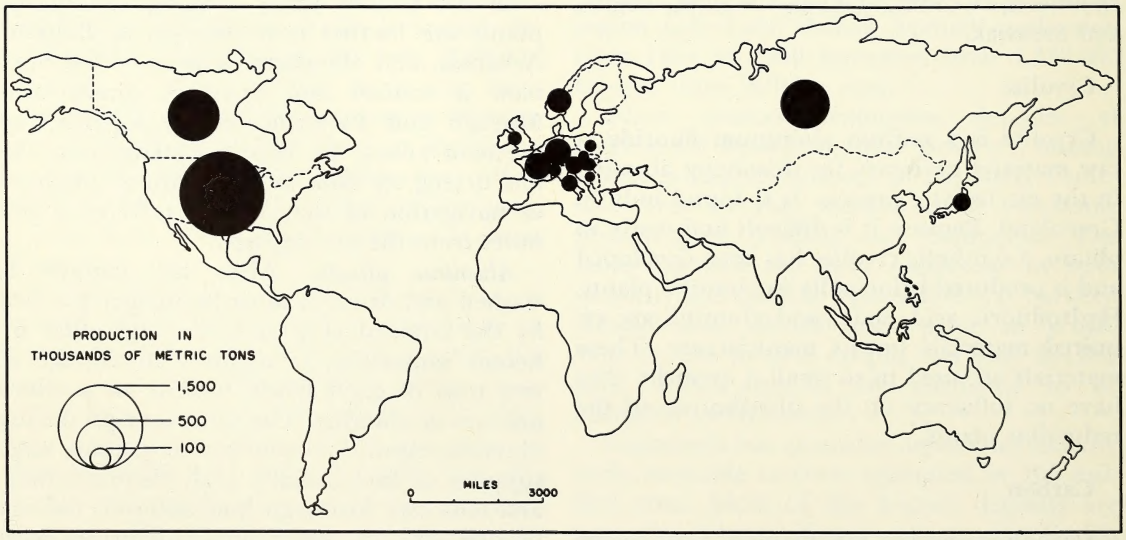
Alumina plants. After the bauxite is washed and dried, it must be further purified by the removal of iron, silica, and other inherent impurities. It requires an average of two tons of good grade bauxite to produce one ton of alumina. The process of producing alumina requires, in addition to bauxite, large supplies of fuel, usually coal, chemical lime, and soda ash. Although lime and soda ash are needed only in rather small quantities with high-grade bauxite, they are consumed in large

amounts when high silica ores are used. Fluorspar must also be available if synthetic cryolite and aluminum fluoride are to be produced at the alumina plant. Accessiblity to plants making chemicals, abrasives, refractories, and similar goods is a consideration, as well as the distance to the aluminum reduction plants. The cost of transporting alumina to the reduction plants sometimes approximates the cost of producing the alumina. The location of alumina plants is largely determined by the cost of transporting the raw materials to the plant and the alumina to the aluminum reduction plants and to other consuming markets. Thus, alumina plants are generally oriented toward a source of fuel with transportation costs and location of the reduction plants determining the specific location.

Aluminum reduction plants. The primary requisite for commercial production of aluminum from alumina by the electrolytic process is the availability of abundant, low-cost electricity. It requires approximately two pounds of alumina to produce one pound of aluminum. The alumina is dissolved in a cryolite bath for reduction in an electrolytic cell. About 12 kilowatt-hours of electricity are consumed in the production of one pound of aluminum, an amount sufficient to keep a 40-watt light bulb burning continuously for over 12 days. Thus, next to alumina the cost of electrical power is the largest item in the cost of aluminum production. In the United States the cost of power is 20 to 30 per cent of the final price of the metal. Hydroelectric power is usually the lowest cost. Electric power must not only be available at low cost, but service must not be interrupted. Off-peak power, even at low cost, is not attractive to the aluminum industry. When power is discontinued the fuse bath hardens, and remelting is necessary, the final result is a low-grade aluminum. Since about 1955 many of the industrially developed nations have had to seek other sources of low-cost power since their water-power potential is developed nearly to capacity (9). These additional sources of power include natural gas and coal. Germany, prior to World War II, used lignite to produce electricity for its aluminum industry.

WORLD PATTERN OF ALUMINUM PRODUCTION

The aluminum industry has developed in the major industrialized nations and has become particularly important in countries with excess hydroelectric power (Map 8.1). World production increased gradually prior to World War II, from 30,000 tons in 1914 to 647,000 tons in 1939. Between 1935 and 1939, seven countries—Germany, the United States, United



8.1. World—Primary Aluminum Production—1960.

Kingdom, U.S.S.R., France, Italy, and Japan, produced nearly 80 per cent of the world's aluminum. Germany, the largest producer in 1939, had an output of 240,000 tons—about 30 per cent of the world's total.

The increased demand for metal and the destruction of the industry in certain countries during World War II caused significant changes in the distribution of aluminum output. Production in nearly all countries increased in the early war period (4 and 5). Subsequent wartime destruction by military action, sabotage, and economic curtailment reduced plant capacities in Germany, Hungary, U.S.S.R., Norway, Italy, and to a minor extent in France. The United States and Canada emerged during the war as the great aluminum producing nations and in 1945 had approximately 70 per cent of world ingot capacity. In the short space of three years U.S. output increased from about 23 per cent of the world's total in 1940 to 42 per cent in 1943. The growth of the industry in Canada was possibly even more spectacular, with the increase in production rising from 10 per cent in 1940 to 23 per cent of the world's output in 1943.

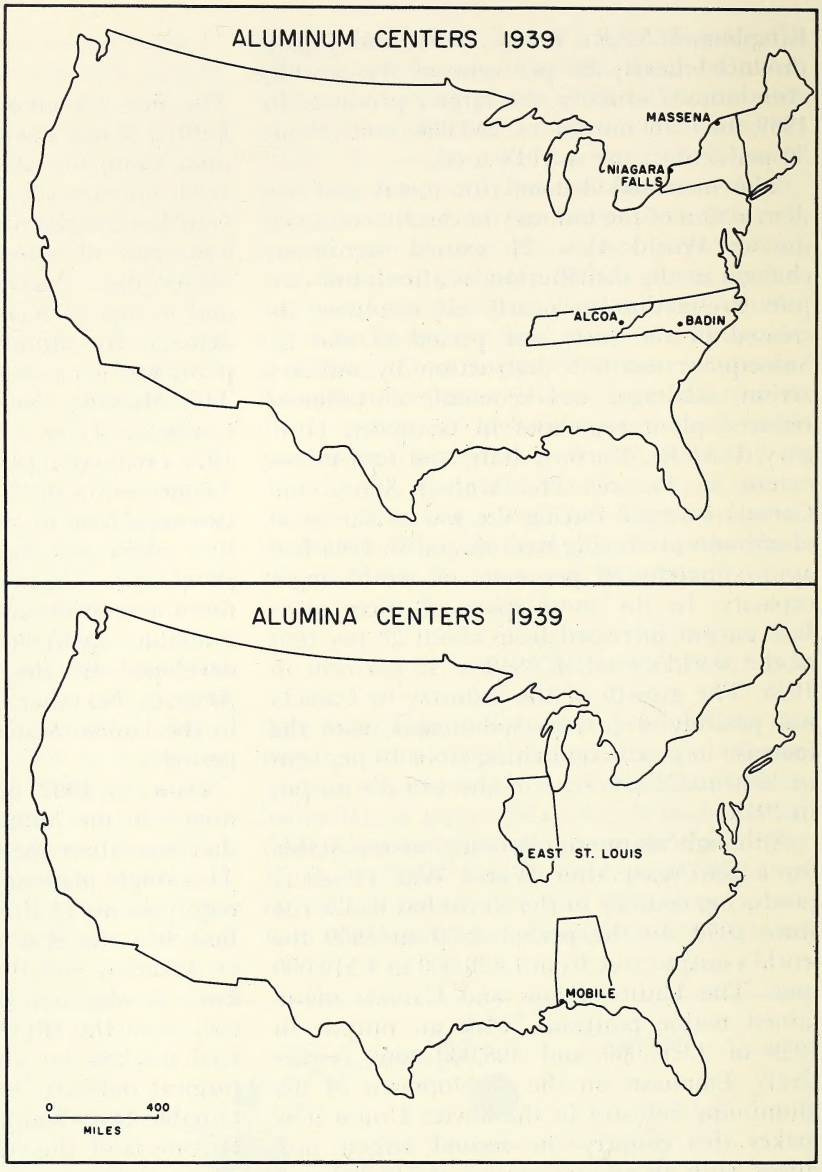
Although aluminum production was stable for a few years after World War II, every producing country in the world has had a rise since 1950. In the period 1950 to 1959 the world's output rose from 1,480,000 to 4,510,000 tons. The United States and Canada maintained major positions, with an output in 1959 of 1,953,000 and 598,000 tons respectively. Emphasis on the development of the aluminum industry in the Soviet Union now makes this country the second largest producer, with an annual output of 715,000 tons in 1959. These three countries produce about 72 per cent of the world's primary aluminum. The important aluminum producers of Western Europe in 1959 in order of output were: France, 190,000 tons; West Germany, 166,000 tons; Norway, 159,000 tons; Italy, 82,000 tons; Austria, 72,000 tons; Hungary, 50,000 tons; and East Germany, 38,000 tons. The output of Western Europe is about 20 per cent of the world's total. Japan, with a production of 109,000 tons in 1959, was the major producer in Asia, followed by China with 77,000 tons.

UNITED STATES

The first aluminum reduction plant in the United States was constructed by the Aluminum Company of America at Pittsburgh in 1888, but was soon moved 50 miles north to New Kensington on the Allegheny River. The high cost of electrical energy in this area caused the reduction plant to be dismantled and moved to Niagara Falls in 1895. As the demand for aluminum grew this reduction plant was expanded and new sites developed. The Massena, New York plant on the St. Lawrence River was constructed in 1903. In 1914 a reduction plant was completed at Alcoa, Tennessee on the Little Tennessee River and two years later in 1916 the Badin, North Carolina plant was built on the Yadkin River (Map 8.2). These sites were chosen because there was little or no competition for the available hydroelectric power, which was developed by the Aluminum Company of America. No other reduction plants were built in the United States until the World War II period.

Prior to 1902 most of the alumina consumed in the industry was imported, but in that year Alcoa opened its East St. Louis plant. This single plant supplied the entire alumina requirements of the United States until 1938. East St. Louis is situated between the bauxite of Arkansas and the reduction plants of the East. It also has the advantage of low-cost coal from the Illinois fields as well as industrial markets for alumina outside the metallurgical industry. Foreign bauxite is also obtainable from South America by way of New Orleans and the Mississippi River. In 1938 Alcoa built its second alumina plant at Mobile, Alabama. This plant is in an excellent position to process Caribbean ores as they enter this country and supply the reduction plants of Alabama, Tennessee, and North Carolina.

Prior to World War II there was a relatively slow but on the whole steady increase in production of aluminum, from nearly 70,000 tons in 1920 to 187,000 in 1939. During World War II consumption was unprecedented, particularly because of the enormous production of aircraft, in which aluminum is the dominant material. The United States expanded

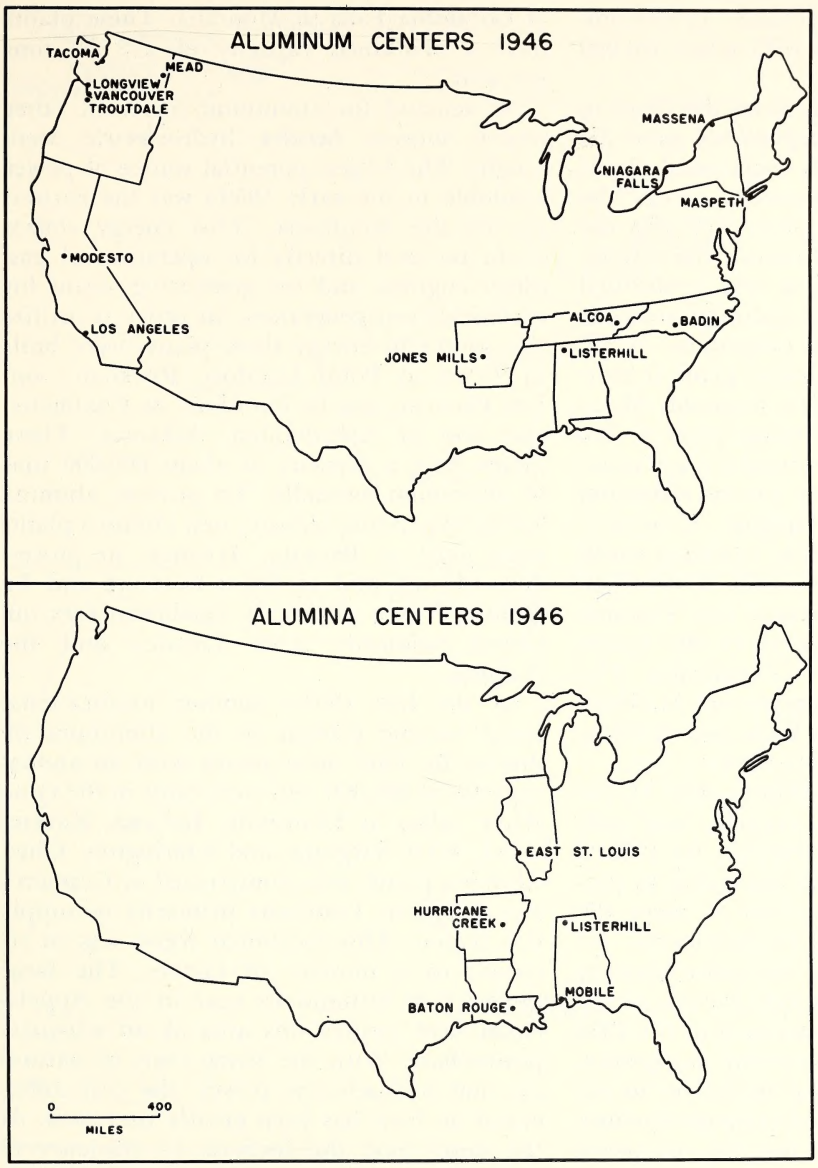


8.2. United States—Aluminum and Alumina Centers—1939.

the capacity of the aluminum industry by more than 300 per cent between 1940 and 1945. Aluminum was the first metal placed under priority ruling during the war, but production increased so rapidly that it was the first metal freed from priority control.

The tremendous growth was accomplished by expansion of facilities in private industry and the development of vast government projects (Map 8.3). The Aluminum Company of America expanded their existing facilities and in 1941 built the first aluminum reduction plant on the Pacific Coast at Vancouver, Washington. By 1942 the annual capacity of Alcoa's plants was approximately 400,000 tons. Although this company was the sole producer of primary aluminum until 1941, the Reynolds Metal Company, originally engaged in fabrication only, became a producer of the metal that year. This company built an alumina and reduction plant at Listerhill, Alabama and also erected a reduction plant at Longview, Washington.

Since private companies did not expand the



8.3. United States—Aluminum and Alumina Centers—1946.

industry sufficiently, the U.S. government became a primary producer of the metal (20). It erected two alumina plants, one at Hurricane Creek, Arkansas, near the domestic bauxite deposits, and the other at Baton Rouge, Louisiana, to process Guiana ore. The annual capacity of the Arkansas plant was 778,000 tons and that of Louisiana, 500,000. Both plants were operated during the war by Alcoa. Between 1941 and 1943 the government also built nine additional reduction plants, eight of them leased and operated by Alcoa and the ninth by the Olin Corporation. These plants were located at Maspeth (Queens, Long Island) and Massena, New York; Jones Mills, Arkansas; Los Angeles and Modesto (Riverbank), California; Troutdale, Oregon; Burlington, New Jersey; and Mead (Spokane) and Tacoma, Washington (13). The government plants, with a capacity of over 635,000 tons annually, were frequently located where excess electricity existed, although this electricity was sometimes high cost. As a result of the expansion by private companies and erection of

government plants aluminum production trebled between 1941 and 1943 when 920,000 tons were produced.

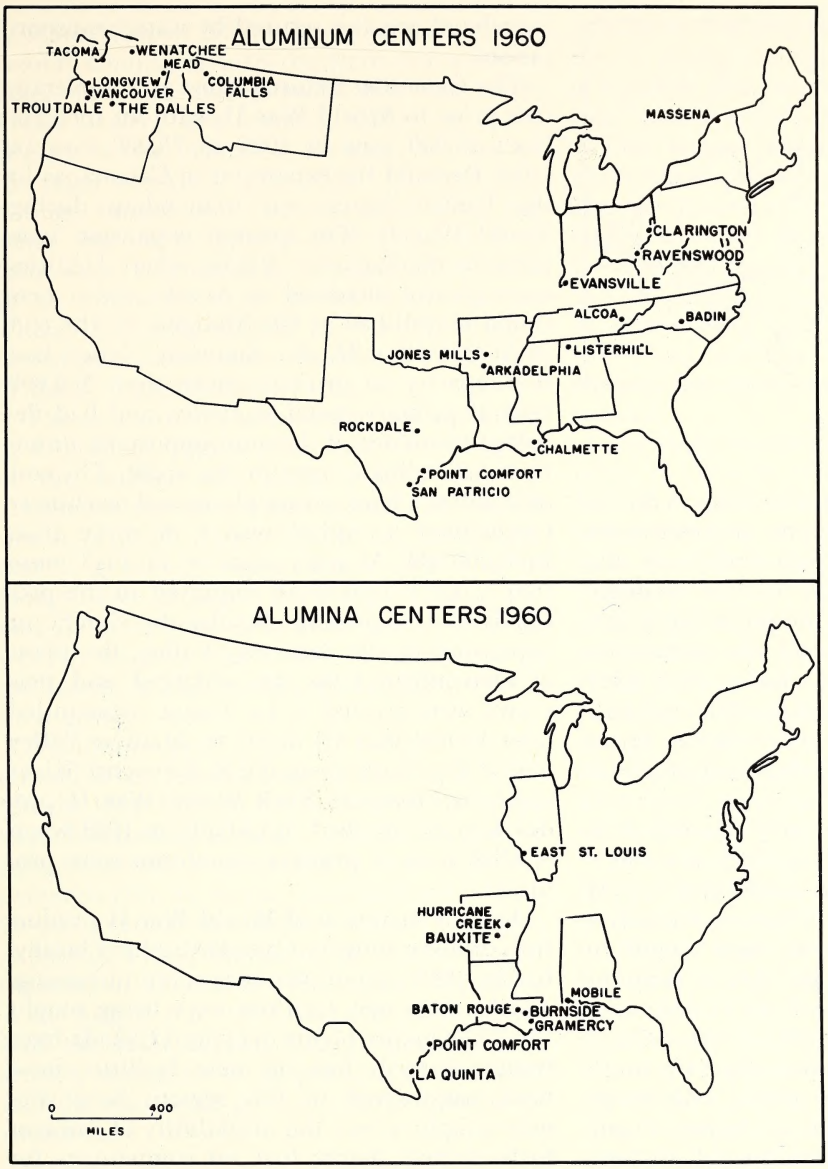
At the conclusion of hostilities the Government's Defense Corporation plants were declared surplus and the most economical plants were sold to private companies. Under the terms of the Surplus Property Act and the rulings of the Attorney General, the Aluminum Company of America was prohibited from acquiring any of the surplus government plants that would tend to perpetuate its adjudged monopoly. The alumina plant at Hurricane Creek was sold to the Reynolds Metal Company and the Baton Rouge plant to the Kaiser Aluminum and Chemical Corporation, a newcomer in the industry. Of the reduction plants, the Troutdale, Oregon; Longview, Washington; and Jones Mills, Arkansas works were purchased by the Reynolds Metal Company, and the Mead (Spokane) and Tacoma, Washington plants were sold to the Kaiser Aluminum and Chemical Corporation. The high-cost plants at Los Angeles and Modesto, California; Maspeth, New York; and Burlington, New Jersey, were dismantled.

For a few years after World War II the United States' developed capacity was sufficient to meet demands. However, by 1950 it became evident that a large expansion in production facilities was required to meet the growing metal market. Requirements for civilian consumption were increasing steadily and military needs rose sharply because of the Korean hostilities. The enactment of the 1950 Defense Production Act enabled the government to offer the following incentives to the aluminum industry for expanding production: accelerated amortization for tax purposes, guaranteed loans, subsidies to offset excess cost of power, and a guaranteed market for metal produced from the new facilities.

The major problem of aluminum industry expansion in the 1950's was that of securing adequate low-cost power. The traditional regions of low-cost hydroelectric power in the southern Appalachians and in the Northwest were able to offer only a few new sites. Three new plants have been oriented to hydroelectric power sources (Map 8.4). Two of these are in the Northwest at Wenatchee, Washington, and The Dalles, Oregon, and the third is situated at Columbia Falls in Montana. These plants have a combined capacity of 222,000 tons per year.

As demand for aluminum increased other power sources besides hydroelectric were sought. The largest potential source of power available in the early 1950's was the natural gas of the Southwest. This energy source could be used directly for operation of gas-diesel engines, and for generating steam for turbine-driven generators. In order to utilize this source of energy three plants were built in Texas at Point Comfort, Rockdale, and San Patricio, one in Louisiana at Chalmette, and one at Arkadelphia, Arkansas. These plants have a capacity of about 600,000 tons of aluminum annually. To provide alumina for the expanding industry new alumina plants were built at Bauxite, Arkansas to process domestic ore and at Point Comfort and La Quinta, Texas to process Caribbean ores imported primarily from Jamaica and the Guianas.

In the late 1950's another localizational trend became evident in the aluminum industry. By 1960 three plants with an annual capacity of 485,000 tons were built in the Ohio River valley at Evansville, Indiana, Ravenswood, West Virginia, and Clarington, Ohio. Alumina plants were constructed at Gramercy and Burnside, Louisiana primarily to supply this region. This locational trend was in response to a number of factors. The large quantity of bituminous coal in the Appalachian field assures this area of an adequate power base. With the rising costs of natural gas and hydroelectric power, the cost differential on fuels has been greatly narrowed. At the same time the increase in efficiency of power generation for steam plants has made coal competitive with other fuels in electrical power generation. The Ohio River also provides for low-cost transportation from the Gulf Coast and lower Mississippi alumina plants, and the excellent rail and highway network enables the finished products to reach their market. The Ohio Valley can provide a large supply of labor to the aluminum industry. Finally, the new plants are to a large degree market oriented. More than two-thirds of the nation's aluminum market lies within 500 miles of the Ohio Valley plants.

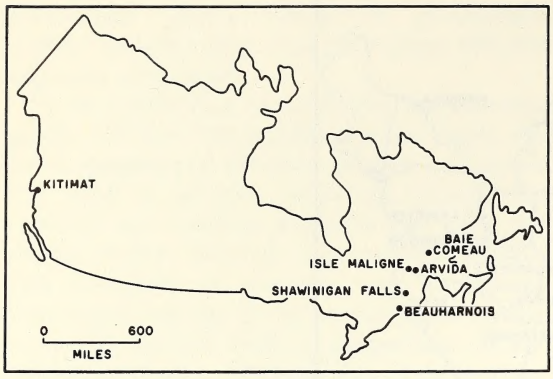


8.4. United States—Aluminum and Alumina Centers—1960.

As a result of the changing geographical pattern of aluminum reduction plants, the pattern of aluminum production has also been altered greatly since 1940. Before World War II all facilities were located in eastern United States. As a result of the expansion in western United States, approximately 40 per cent of the metal producing capacity in 1950 was concentrated in Washington and Oregon. About 10 per cent was located in Arkansas, and approximately 50 per cent remained in the East. By 1960, the Northwest possessed about 26 per cent of the aluminum producing capacity. The Gulf Coast states of Texas and Louisiana had approximately 21 per cent of the national capacity. Arkansas had 7 per cent, the Ohio Valley 19 per cent, and the remainder was in the old established centers in the East.

CANADA

Establishment of aluminum production in Canada resulted from the growth of the in-



8.5. Canada—Aluminum Centers.

dustry in the United States (Map 8.5). In 1899 the Aluminum Company of America established the first plant and undertook the construction of a reduction plant at Shawinigan Falls, Quebec. It was the potential hydroelectric power that attracted the aluminum industry to the St. Maurice River. This river drops 1,300 feet in a series of cascades and falls throughout its 240-mile length, offering favorable conditions for the development of power sites.

The growth of the industry proceeded as world demands increased. By 1925 the single plant at Shawinigan Falls could not supply the needs of the industry. New sites for hydroelectric power developments were sought in the Saguenay Valley, which has a drop of more than 300 feet between Lake St. John and tidewater, 30 miles downstream. In 1925, a 540,000-kilowatt capacity plant was built south of Lake St. John. This, together with favorable sites for additional power farther downstream, justified the construction of an integrated aluminum industry at Arvida.

As a result of the availability of cheap hydroelectric power and the assembly of all raw materials made possible by water transportation, the Saguenay Valley is reported to have the world's lowest aluminum production costs. Canada has no domestic deposits of bauxite, and she secures most of her needs by import from British Guiana and Jamaica. Ocean-going vessels can go up the Saguenay River as far as Port Alfred, within 20 miles of Arvida. Petroleum coke from Texas, cryolite from Greenland, and fluorspar from Newfoundland are also secured by water transportation.

The Canadian industry grew at a moderate rate prior to World War II, with an increase from 25,000 tons in 1925 to 75,000 tons in 1939. Demand for expansion in Canada, as in the United States, was tremendous during World War II. The greatest expansion took place in the Saguenay Valley, where facilities were greatly increased at Arvida and a new center established at Isle Maligne. At the end of World War II, the Saguenay Valley had the capacity to produce more than 350,000 tons of primary metal annually, and had developed into one of the most important aluminum producing centers in the world. The cost of buildings, land, power plants and machinery represented a capital outlay of more than $400,000,000. At peak capacity in 1943 more than 7,000 people were employed in the production of aluminum. Besides the significant expansion in the Saguenay Valley, the plant at Shawinigan Falls was enlarged and new plants were erected at La Tuque (dismantled after World War II) in the St. Maurice Valley and at Beauharnois on the St. Lawrence River south of Montreal. Peak World War II production was reached in Canada in 1943 when 450,000 tons of primary aluminum were produced.

At the conclusion of World War II production of aluminum in Canada declined briefly, but by 1948 output was once again increasing, and by 1950 new facilities were being sought (3). The Quebec plants in eastern Canada have been enlarged, but no new facilities have been constructed in this region. New sites were sought where the availability of low-cost hydroelectric power had no competitors for its use. This was the major criterion that was considered in the selection of Kitimat, which lies on the British Columbia coast, as the new center of aluminum production in Canada.

Immense hydroelectric power reserves are in an initial stage of development in the Coastal Ranges of western Canada. A combination of rugged topography and abundant precipitation has created a great water-power potential. In 1952 one of the world's largest power projects was built at the primitive Indian village of Kitimat, about 50 miles south

of Prince Rupert. High above this hamlet, the coastal mountains turn the waters of a dozen lakes and streams eastward into the large Fraser River. The eastern outlet of these streams is now dammed, turning the flow of the lakes westward. This water, directed into a huge tunnel that extends more than ten miles into the mountains with a fall of over 2,600 feet, is carried to a powerhouse built in an enormous cave in the mountainside. There the force created by the fall is converted into power and transmitted to the site of the new aluminum industry.

The first primary aluminum was produced at Kitimat in August 1954. The 1960 capacity of the smelter was about 192,000 tons of aluminum, but an eventual capacity of 550,000 tons is planned. As production increases, Kitimat is gradually being transformed into a modern city of many thousands. This is the first of numerous favorable power sites in western Canada which may be developed in the future as the world's demand for aluminum grows.

Aluminum production in Canada has increased from 396,880 tons in 1950 to 598,000 tons in 1959. Canada has developed an aluminum fabricating industry, but its output of primary metals is much higher than domestic demands (16). In recent years between 75 and 90 per cent of the annual output has been exported. Thus, Canada is the world's largest exporter of aluminum. The United Kingdom is the largest purchaser, usually taking about half the total export. The United States is second, taking about 20 per cent of the total, and the remainder goes to a large number of countries.

SOVIET UNION

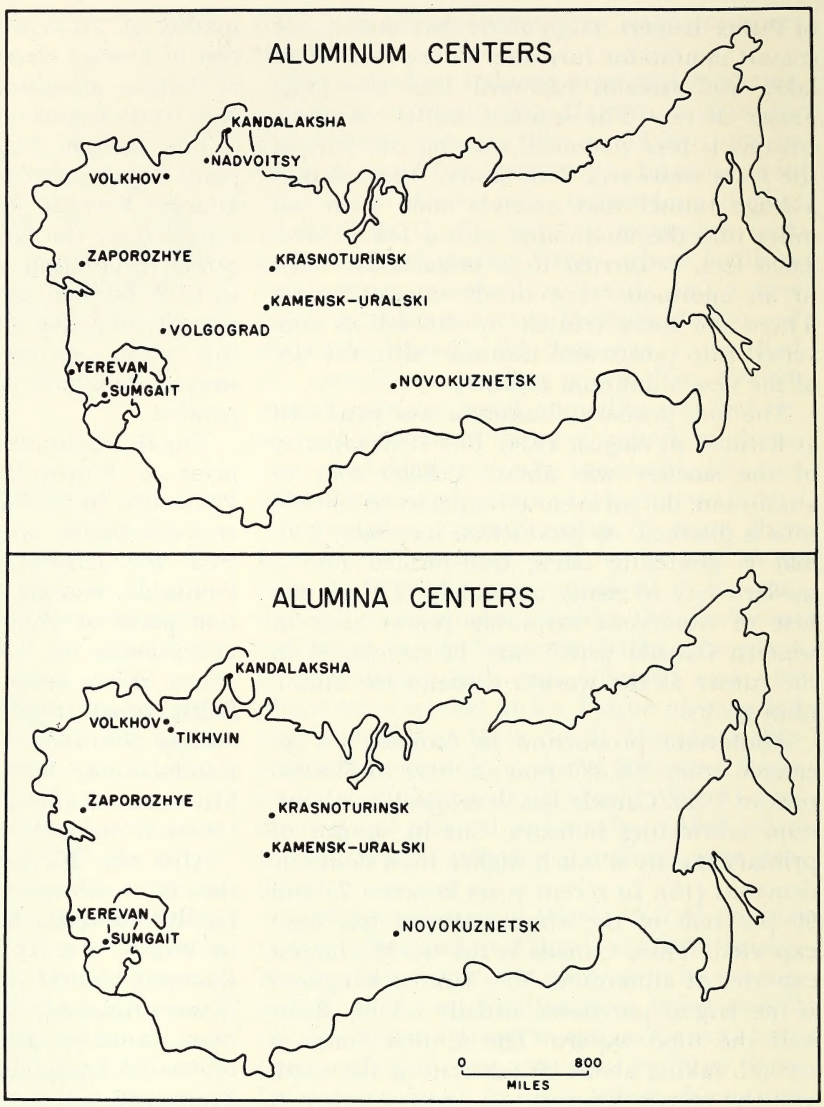
The primary production of aluminum began in the U.S.S.R. in 1932 with the construction of the Volkhov aluminum works about 75 miles east of Leningrad (Map 8.6). The location of this plant was determined by the Zvanka hydroelectric power plant on the Volkhov River and the Tikhvin bauxite deposits about 63 miles to the southeast by railroad. In 1940 this plant is said to have produced 13,000 tons of aluminum. Because of the poor quality of Tikhvin ore and the relative high-cost of Zvanka electricity, the production cost of Volkhov aluminum is estimated to be about four times as great as in most countries.

The second Soviet aluminum reduction plant began production at Zaporozhye on the Dnieper River in 1935. Electric power was obtained from the 90,000-kilowatt hydroelectric power installation on the Dnieper River, and in 1940 the plant had an aluminum reduction capacity of 35,000 tons. During World War II this plant and the power station were destroyed, but have since been rebuilt and expanded.

The third aluminum center to be developed prior to World War II was on the Kola Peninsula. In 1937 an alumina plant was built at Kandalaksha to process the waste materials from the apatite rock mined on the Kola Peninsula, and in 1939 an aluminum reduction plant of 10,000 tons capacity was built at Sosnovets on the shore of the White Sea. Water power from dams on the White Sea-Baltic canal supplied the necessary electric energy. Sosnovets is about 200 miles south of Kandalaksha, both being located on the Murmansk Railroad for convenient transportation of materials and the finished metal.

After the discovery of bauxite deposits in the Ural Mountains, aluminum reduction facilities were established in this region. Prior to World War II the largest center was at Kamensk-Uralski on the Iset River. In 1940 it was producing 10,000 metric tons of aluminum annually. During World War II the evacuated equipment from the Volkhov and Zaporozhye plants was brought to Kamensk. The Kamensk works was considerably expanded with the demands of war and was the mainstay of Russian output between 1941 and 1945.

The growth of the Russian aluminum industry in recent years has been spectacular (15). Output has risen from 190,000 tons in 1950 to over 750,000 tons in 1960. In order to achieve this production the capacity of the older centers has been increased and new centers have been built. The Urals have evolved as the major region of aluminum production with plants at Kamensk and a new larger center at Krasnoturinsk. This latter center is located in the vicinity of the large



8.6. Soviet Union—Aluminum and Alumina Centers.

bauxite deposits of Severouralsk. In 1960 the capacity of plants in the Ural region was estimated to be at more than 270,000 tons annually.

Other new aluminum centers in the Soviet Union are oriented to power sources and regional markets. The new interior locations also reflect the established policy of the Soviet government to move industry eastward. In the Middle Volga region an 88,000-ton capacity plant began operating in January 1959. Power for this plant is secured from the Kuybyshev Dam. In the Caucasus area two aluminum centers are located at Yerevan and Sumgait. These plants have a combined annual capacity of 104,500 tons. The Yerevan plant is linked to the three hydroelectric power dams of the Svan-Sanga Falls. Sumgait utilizes both hydroelectric power and petroleum from the Baku fields. Another new development is the reduction plant at Novokuznetsk in the Kuznetsk Basin of Siberia. Power is supplied by the Kemerovo power station, which is fueled by coal from the area. Alumina is supplied by the local alumina plant and also by the Kamensk plant in the Urals. New plants under construction or planned include Pavlodar, Krasnoyarsk, Perm, and Angara.

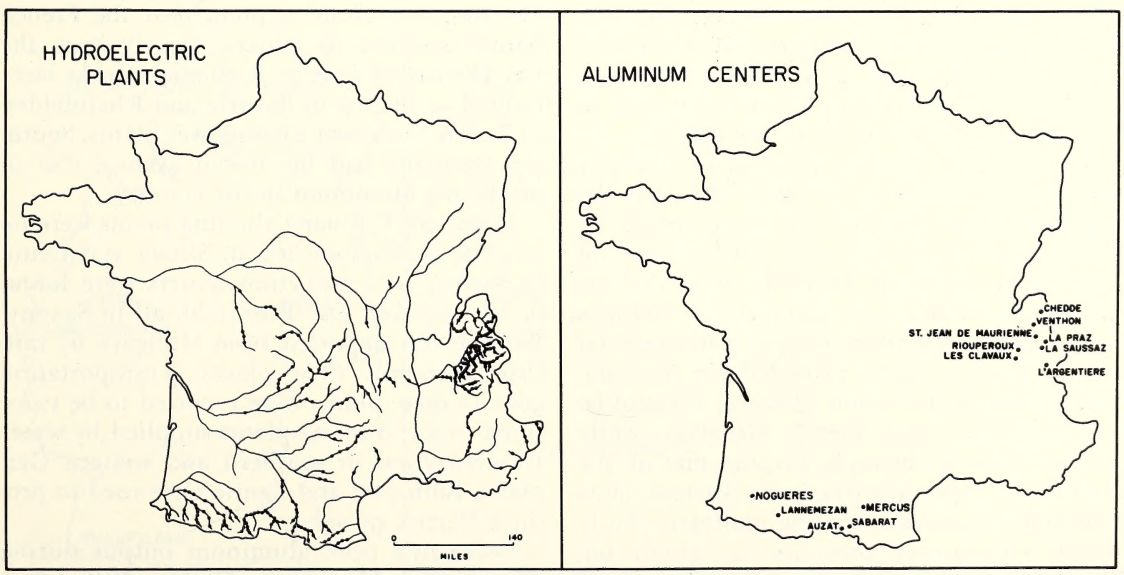
FRANCE

France is one of the oldest producers of aluminum in the world. The first reduction plant was constructed in the early 1890's, but prior to 1935 annual production never exceeded 15,000 tons. During the latter portion of the 1930's and the early World War II years production increased, reaching a peak in 1941 when nearly 64,000 tons were produced. As a result of the French military defeat, production declined to a low of 26,000 tons in 1944. The aluminum industry has experienced rapid growth in the postwar period (17). Annual output has risen from 66,800 tons in 1950 to 190,000 tons in 1959.

The aluminum industry is located in southern France, with the alumina plants generally oriented toward the bauxite deposits and the reduction plants oriented toward hydroelectric or natural gas power sources (Map 8.7). There are five alumina plants in France located at La Barasse, St. Louis-les-Aygalades, Gardanne, St. Auban, and Salindres. The first three lie between the ore deposits of the Var and Bouches-du-Rhône and the port of Marseilles. Thus, these districts are favorably located for shipment of the alumina northward to reduction plants or southward for export. The St. Auban plant on the Durance River refines Var bauxite for use in the reduction plant at the same location. The plant at Salindres uses Hérault bauxite and supplies alumina to the reduction plants on the northern slopes of the Pyrenees.

In 1961 there were 13 reduction plants located in the French Alps and the Pyrenees, with a total annual capacity of 252,000 tons. In the Alps the plants are located at Chedde, Venthon, St. Jean-de-Maurienne, La Praz, La Saussaz, Les Clavaux, Argentière, and Rioupéroux. The remaining five are at Lannemezan, Nogueres, Sabarat, Mercus, and Auzat, all on the northern slopes of the Pyrenees. Approximately 70 per cent of the total aluminum output is produced in the Alps and 30 per cent in the Pyrenees.

Until 1957 the reduction plants were located on or near hydroelectric power sites. East of the Rhone River, the plants are situated on the Arc, Durance, Arve, Romanche, and Fier rivers. Two of the plants in the Pyrenees are on the Ariège and Neste rivers. Most of the reduction plants have their own power stations. Since the electrical capacity of the short streams is relatively limited the reduction works are small. By 1954 the expansion of the aluminum industry had utilized most of the available potential hydroelectric power. Because of the high cost of additional hydroelec-



8.7. France—Hydroelectric Plants and Aluminum Centers.

tric power, new facilities must seek other power sources. In 1957 plans for expanding the aluminum industry in France by using the Lacq area natural gas of southwestern France to produce thermal electricity were initiated. The project, completed in 1960, consists of a thermal power plant and two aluminum reduction plants at Lannemezan and Nogueres.

French interests have also negotiated an agreement to develop the abundant supply of hydroelectric power resources in the Cameroons to produce aluminum. In 1957 initial production began and in 1959 the Cameroons produced 46,600 tons of aluminum. The bauxite for this development comes primarily from deposits in Guinea.

GERMANY

The aluminum industry developed relatively late in Germany. The first impetus to growth of production came with the demands for metal in World War I, and during this period five reduction plants were constructed. Continued expansion during the 1920's, however, was handicapped both by lack of suitable domestic bauxite and by the use of high-cost electricity. All producing plants of this period were supplied with electricity from thermal units which used lignite or coal as fuel. The reduction plants at Rummelsburg, Horrem, and Bitterfeld were closed after World War I because of high-cost production. Only the Grevenbroich and Lauta plants were able to continue production through the 1920's.

The world depression resulted in a drastic decline in production. In 1933, although the capacity of the country was estimated to be 47,000 tons annually, only 19,000 tons of metal were produced. However, with the rise of Hitler, aluminum production facilities were rapidly expanded through governmental orders. A state decree provided for the compulsory use of aluminum wherever it could be substituted for other metals. Germany, while lacking bauxite deposits, became one of the leaders in experimenting with various clays and other aluminum bearing materials. Technically satisfactory processes for producing aluminum from clay were reported, and in 1939, 8,000 tons of aluminum were produced from this source at a large-scale experimental plant at Lippe, Westphalia.

As a consequence of this government program there was a phenomenal rise in German production during the 1930's. By 1939 annual output was about 240,000 tons, and Germany was the world's leading producer. At the beginning of World War II the German aluminum industry was located in three regions: (1) in the Rhineland and Westphalia, (2) in Saxony and adjacent Silesia, and (3) in Bavaria and Baden.

In the first region three alumina plants at Duisburg, Bergheim, and Lunen and two reduction plants at Grevenbroich and Lunen constituted the industry in western Germany. The alumina plants were favorably situated for imports of bauxite by sea from Yugoslavia, Greece, and Italy. Coal and lignite were available for electric power developments. Although power was fairly high cost in this area, the plants were oriented in respect to the fabricating factories in the industrial Rhine Valley and associated regions.

In Bavaria and Baden the alumina plants were oriented toward foreign bauxite sources while the reduction plants were situated near hydroelectric power plants. The Schwandorf alumina plant profited from a short haul and cheap transportation on the Danube River in receiving bauxite from Hungary. The Mundenheim alumina plant near the French border received its bauxite largely from the Var District of France. Reduction works were located at Toging in Bavaria and Rheinfelden in Baden, both near hydropower plants. Southern Germany had the lowest average cost of producing aluminum in the country.

In eastern Germany alumina plants were located at Goldschmieden in Silesia and Lauta in Saxony, and reduction centers were found in Lauta, Oker, and Bitterfeld, all in Saxony. Bauxite was imported from Hungary by railroad to supply these plants. Transportation costs to these plants were reported to be twice those to the alumina plants supplied by water transportation in southern and western Germany. Both coal and lignite were used to produce electric power.

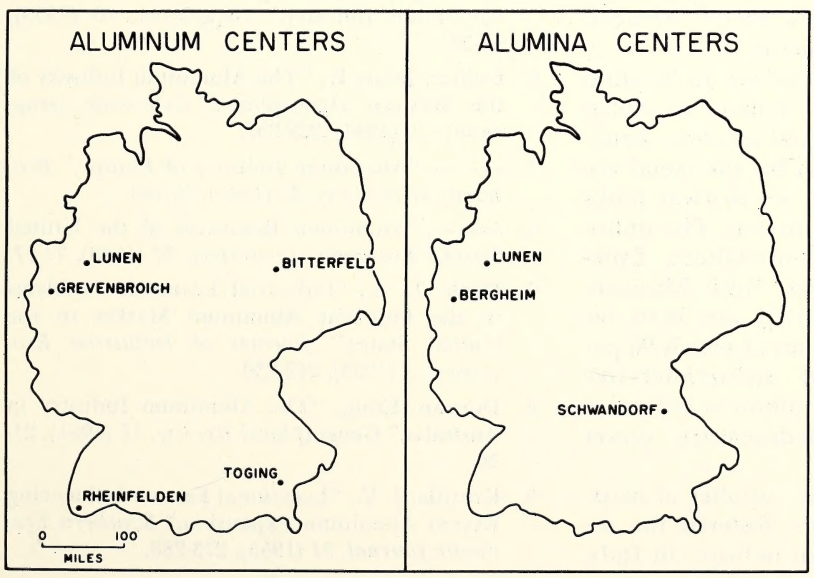
Germany's peak aluminum output during World War II was reached in 1942 when 227,000 tons were produced. Production de-

clined after this date and in 1945 all aluminum production was stopped by Allied decree. War damage to aluminum facilities was moderate. With the occupation of Germany about 45 per cent of the aluminum capacity was in the Russian Zone and 55 per cent in the Western Zone. In October 1946 the Allied Control Council in Berlin announced that 45 plants engaged in the manufacture of alumina, primary and secondary metal, alloys, and wrought and cast products were to be dismantled for reparation payments. Dismantling proceeded slowly, particularly in the Western Zone. In 1948 the order was rescinded and West Germany was granted permission to produce primary aluminum once again. Beginning in 1949 the German aluminum industry was revitalized, and Germany has once again become a major producer. Production in the postwar period is primarily centered in West Germany (Map 8.8). There has been no locational change of the alumina industry in West Germany since 1948. Alumina plants are situated at Lunen, Bergheim, and Schwandorf. The reduction plants are located at Rheinfelden, Toging, Grevenbroich, and Lünen. In East Germany aluminum is produced at Bitterfeld. The reduction plants at Lauta and Oker were dismantled, and the one at Goldschmieden is now in Poland. In 1961 the Lauta plant was being rebuilt and will be in full production by 1964, with an annual capacity of 22,000 tons.

In 1949 West Germany produced 24,000 tons of aluminum. By 1959 the output had risen to 166,000 tons. Production in East Germany during the 1950's rose from 10,700 tons in 1953 to 38,600 in 1959.

AUSTRIA

Prior to World War II aluminum production in Austria did not exceed 5,000 tons annually from two small plants at Steeg and Lend. After the German conquest of Austria, and with the integration of the Austrian economy with that of Germany, a mammoth reduction plant was constructed at Ranshofen. This plant utilized the low-cost hydroelectric power of the Alps and bauxite was transported from Hungary on the Danube River. The Ranshofen plant was developed to supply aluminum to eastern Europe. Austrian output increased from 6,675 tons in 1940 to a World War II peak of 52,100 tons in 1944. Output declined sharply at the conclusion of World War II, but began its recovery in 1947. Because of increased demand a second aluminum reduction plant was built at Lend in the 1950's. In 1959 Austria produced 72,270 tons of aluminum. This amount was greatly in excess of domestic needs, and Austria has become an exporter of aluminum.



8.8. Germany—Aluminum and Alumina Centers.

JAPAN

Japan is the major producer of aluminum in Asia. Under governmental sponsorship the industry began in 1934 to supply military needs. Japan imported bauxite from the Netherlands East Indies (Indonesia) and developed alumina and reduction plants not only on the Japanese islands, but also in Korea and Manchuria. Peak production was reached in 1944 when 109,000 tons were produced. In the early postwar period production was controlled for a number of years. Since 1950, output has risen continually to 109,000 tons in 1959. Five centers, Kitakata, Omachi, Kambara, Niigata, and Kikumoto have an annual capacity of 127,000 tons.

OTHER COUNTRIES

A number of countries have developed a small aluminum industry. United Kingdom has become nearly self-sufficient in aluminum by importing bauxite and processing it within the country. Output, however, has always been small. Production began in 1890 and increased to 5,000 tons by 1910. Wartime stimulation increased output to 8,300 tons in 1918. Through a gradual expansion, which was hindered by the 1930's depression, production rose to about 25,000 tons in 1939, and reached a World War II peak in 1943 of nearly 57,000 tons. Production from plants at Kinlochleven and Lochaber during the 1950's varied between 27,000 and 33,000 tons annually.

Norway illustrates the influence in locating the aluminum industry at sources of cheap hydroelectric power near good seaports. Bauxite, coal, and a large market for the metal are lacking within the country, yet Norway ranks fifth or sixth in world production. The industry is located at Aardal, Sunndalsora, Eydehamn, Tyssedal, Hoyanger, and Mosjoen. Annual production since 1955 has been between 65,000 and 159,000 tons of which 90 per cent is normally exported. Switzerland like Norway has attracted the aluminum reduction industry because of its hydroelectric power resources.

The presence of adequate supplies of bauxite and hydroelectric power fostered the development of the aluminum industry in Italy. Under government stimulus the industry expanded rapidly during the 1930's and World War II. A peak production of 46,000 tons was reached in 1943; after Italy's defeat, production declined drastically. By 1948, however, the industry was recovering, and 33,000 tons of aluminum were produced that year. A production in 1959 of 82,600 tons was achieved in the four centers of Mori, Bolzano, Porto Marghera, and Borgofranco d'Ivrea.

The aluminum industry of mainland China has experienced remarkable growth in recent years. Output is reported to have risen from 11,000 tons in 1955 to 77,600 in 1959. Fushun in Manchuria was the original center of production. The expansion of the Fushun plant to a 66,000-ton capacity in 1958 contributed to the estimated 160 per cent increase in output in 1959. Other small plants are located at Kweiyang, Kweichow Province, and Hofei, Anhwei Province. A new aluminum plant with an estimated capacity of 110,000 tons was under construction in 1960 in Sian, Shensi Province.

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CHAPTER NINE

MACHINE TOOL INDUSTRY

The machine tool industry provides the basis for all engineering industries. Although the importance of the industry is not always recognized by the layman it is the machine tool which makes possible interchangeable parts in mass-production manufacturing. The machine tool industry is of extreme importance because it has made low-cost quantity production possible. In the modern automobile engine there are between 30,000 and 35,000 parts. It is only because each is machined accurately to size that the semi-skilled mechanic can assemble them and produce an engine which will operate. In the early part of the nineteenth century making an axe, for instance, required fashioning a head and then making a handle to fit it. Then the process was begun all over again. Today, an automobile manufacturer can take any one of 100,000 piston heads and fit them with any one of 100,000 cylinders and know that the fit will be perfect. It is the machine tool builder's ability to say to the engineer, "You design it and I'll build it," that has made possible the machine age (11).

The machine tool industry is comparatively small considering its importance. There is a limited demand for its products, because they are of direct economic value, not to the public consumer, but to the manufacturer. It is also an unusual industry because of the high degree of skill required of its workers and its high rate of employment per unit of output. In the conversion of metal into finished machine tools, the value added by labor is usually four to five times that added in other metal manufacturing plants and may aggregate from 50 to 60 per cent or more of the gross value.

DESCRIPTION OF MACHINE TOOLS

A machine tool is a power-driven instrument used for the precise shaping of metal into a finished article. The lathe, boring machine, and plane comprise the primary metalworking machines. These basic machines are gen-

erally used in conjunction with workholding and tool grinding devices, known as jigs and fixtures, and various precision measuring devices commonly called gauges. A machine tool will range in size from one weighing several pounds to mammoth tools weighing as much as 50 tons.

The varieties and combinations of machine tools in use today are almost numberless. Their function, however, is limited to the five basic factors of metalworking, which are:

1. Milling, which consists of bringing a piece of metal into contact with a rotating cutter having multiple cutting edges and operating like a circular saw.
2. Planing, which consists of machining a surface by moving the work back and forth under a stationary cutting tool. Planing machines may smooth the surface of a piece of metal as large as a room.
3. Turning, which consists of shaping a rotating piece of metal into cylindrical or other curved surfaces with an ordinary lathe, the oldest of all machine tools. A modern turret lathe is so designed that the operator can bring a succession of different cutting edges against the metal time after time to perform the various operations required.
4. Boring or drilling, which consists of cutting, enlarging or finishing a round hole by means of a rotating cutting tool.
5. Grinding, which consists of shaping a piece of metal by bringing it into contact with a rotating abrasive wheel, and includes such finishing processes as polishing and buffing.

LOCATIONAL FACTORS

The manufacture of machine tools is one of the most complicated of all mechanical industries. Because of the great value added in manufacturing, the foremost requirements for machine tool production are the availability of highly skilled mechanical labor and a market. Because skills are acquired only after a long period of training, skilled labor is essentially always found in the older industrial regions. The migration of labor to the newer industrial areas rarely includes a high percentage of the skilled mechanics. Because the machine tool is a product of high value, the availability of raw materials is usually not a factor in its location. It is also a product of relatively small bulk in relation to its value, and it can therefore be shipped great distances.

Within the manufacturing region the machine tool industry is oriented toward the machinery producing centers. There are a number of advantages in locating the industry near one of its largest markets. The ease of making repairs and replacements is an important consideration. The advancement of design in machine tools is most likely to occur where machine tools are used and their effectiveness studied.

WORLD PATTERN OF PRODUCTION

Although machine tools are absolutely essential to the industrial advancement of a nation, most countries still lack the technical ability to produce them. Only the industrially advanced nations have developed a significant machine tool industry. A 1960 world survey by the European Committee for the Cooperation of the Machine Tool Industries showed that the Soviet Union, with an annual output of 160,000 machines, produces the largest number of machine tools. West Germany follows with about 120,000. Communist China is third with an output of about 75,000 units, although most of these are still rudimentary. The machine tool industry of the United States produces about 65,000 units annually. In recent years Japan has been manufacturing more than 30,000 machine tools yearly.

When the importance of the machine tool industry is based on value of production, the United States holds the lead with an output in 1960 of about $700,000,000. The Soviet Union is second with about $550,000,000, followed by West Germany with $500,000,000. The United States now produces about 25 per cent of the world's machine tools. The nine leading western European nations—United Kingdom, France, Switzerland, Italy, West Germany, Austria, Belgium, the Netherlands, and Sweden—produce about 38 per cent of total world output. West Germany produces about 40 per cent by value of the machine tools made in these countries. The Soviet Union and the eastern European nations—Poland, Czechoslovakia, East Germany, and Hungary—produce about 30 per cent of the world total. In recent years the relative im-

portance of the United States as a machine tool producer has declined with the growth in Western Europe and the communist countries.

Because the production of machine tools is concentrated in a few nations and because some nations specialize in particular types of machine tools, there is a thriving international trade. The Netherlands, Switzerland, and Belgium export about 75 per cent by value of their total machine tool production. West Germany exports about 50 per cent and the United States and Great Britain about one-quarter of their output. The Soviet Union is increasing its exports, but still only exports about 5 per cent of its total production. Of the eastern European countries, Czechoslovakia is the leading exporter, with two-thirds to three-fourths of the total machine tools produced being for foreign consumption.

A number of trends in the export of machine tools are evident. For one thing, shipments from continental western European countries are growing rapidly. In contrast the United Kingdom is playing a lesser role in the machine tool trade. Machine tool exports from Western Europe to Latin America increased from about $25,000,000 in 1955 to over $50,000,000 in 1960. In the same period exports to Asia rose from $28,000,000 to over $65,000,000. Another noteworthy trend is the growing trade among western European nations.

The United States' pattern of machine tool trade has been greatly altered in recent years. Shipment to western European countries declined from 48 per cent of total exports based on value in 1955 to 33 per cent in 1960. A similar trend is occurring in shipments to Canada. In contrast, the proportion going to Latin America rose from 13 per cent in 1955 to nearly 30 per cent in 1960, and the proportion to Asia rose from 8 to 18 per cent. The United States' export of machine tools to Brazil rose from $3,500,000 in 1955 to $33,000,000 in 1959.

In 1960 the Soviet Union exported about 6,000 machine tools, Czechoslovakia, 20,000 and Poland, 2,000. These Russian figures, however, do not include the machine tools exported as part of the supply of a plant or of a complete industrial installation. The communist countries of the world are becoming relatively more important.

UNITED STATES

Early centers of production. The machine tool industry had its origin in this country in the machine centers of southern New England. It developed, as its relationships to mass production clearly indicates, at the time when the idea of interchangeabality of parts in manufactured articles became a part of American industrial enterprise. It is generally agreed that the first application of this idea was made by Eli Whitney in a musket factory near New Haven in 1808. Whitney spent several years making the tools which made the manufacture of interchangeable parts practical. By 1815 this idea was being adopted in gun factories throughout southern New England, and soon gained recognition in the making of textile machinery. However, the market was so small that independent machine tool companies were few and machine shops made most of the machine tools. It was not until 1833 that the first company was organized in Providence, Rhode Island to produce machine tools exclusively. During the early period the English machine tools were copied, and few advancements were made in the United States. The industry was characterized by a lack of specialization. In 1860 there were only 17 companies manufacturing machine tools in the United States, with an estimated 450 wage earners. The major centers were in southern New England and Philadelphia.

With the rapid growth of the machinery industry in the Midwest during the latter part of the nineteenth century new centers of machine tools developed. Although eastern factories attempted to produce a full line of machine tools, the midwestern plants specialized in particular machines. By the time of the establishment of the midwestern centers many advancements had been made in machine tools, and the construction of a single tool was frequently a complex operation. As a result specialization in a single machine resulted in the improvement of the product and economy in its production. Specialization in manufacturing of machine tools followed closely the differentiation of processes in other

lines of industry, and thus was created a multitude of special machines, each designed to perform a single and often simple operation. These refinements in production, which are still in progress, are the major contributions of the United States to the machine tool industry.

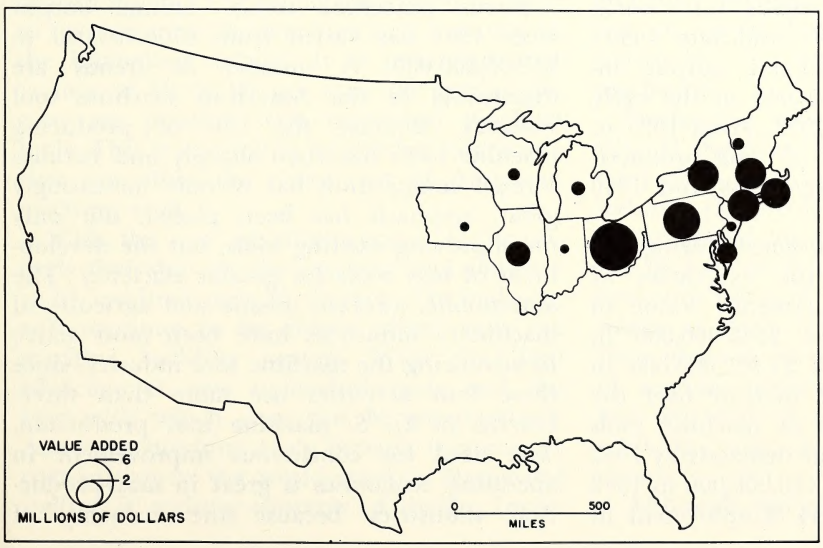
By 1900 the basic geographic pattern of the industry was well established (Map 9.1). New England, Middle Atlantic, and Midwestern states had essentially equal divisions of the machine tool industry. The four leading states in production were Ohio, Pennsylvania, Connecticut, and Massachusetts. The five leading cities, which produced about one-third of the entire output, were Cincinnati, Philadelphia, Providence, Hartford, and Worcester. The balance of the machine tools came from many cities, and also a considerable number of small towns where there was a single establishment, usually making only one type or class of machines.

Modern geographical pattern. Since the early 1900's the automobile industry has been the largest consumer of machine tools. This industry, the prime example of mass production, has thus strongly influenced the location and growth of machine tools in recent decades. If it is true that the machine tool is basic to the mass production of automobiles, it is equally true that the automobile is the mainstay of the machine tool industry. As a consequence the Midwest has increased its share of machine tool production so that in 1958 it produced 62.2 per cent of the nation's output, with Ohio the leading state followed by Illinois, Michigan, and Wisconsin. The Midwestern states also produced about 80 per cent of the machine tool accessories (Map 9.2).

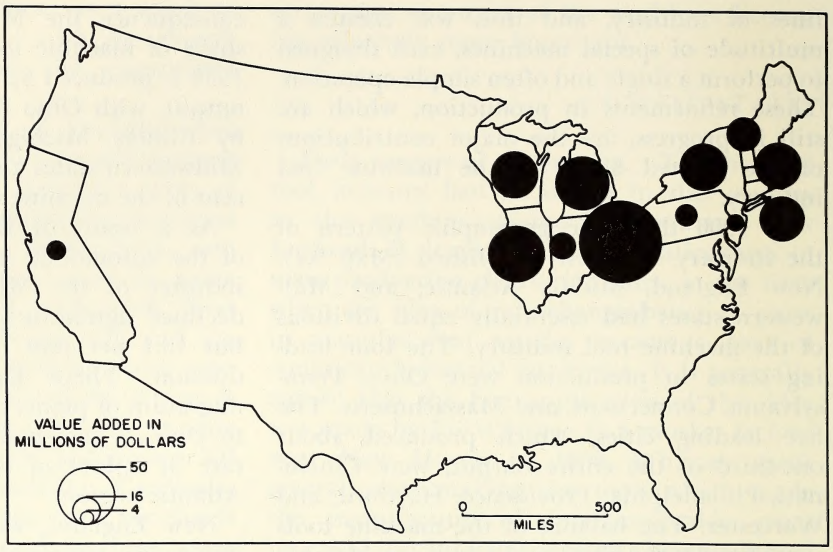
As a result of the centralizing influence of the automobile industry the machine tool industry of the Middle Atlantic states has declined significantly. In 1958 this region had but 10.1 per cent of the nation's tool production. There has been a considerable migration of plants from eastern Pennsylvania to Ohio. There had also been a rather high rate of failure of companies in the Middle Atlantic region.

New England, which remains one of the important electrical and textile machinery centers and an important area of light metal manufacturing, has nevertheless, experienced a gradual decline in its output. In 1958, New England produced 23.5 per cent of the nation's machine tools. The newer industrial regions of the United States such as the South, Southwest, and Pacific Coast have no real machine tool industry.

Production characteristics. The machine tool industry is particularly sensitive to economic conditions. Although machine tools are producer goods rather than consumer goods, it is one of the first industries to decline



9.1. United States—Machine Tool Production—1900.



9.2. United States—Machine Tool Production—1958.

in an economic depression. However, during periods of prosperity or war, the machine tool industry is the first to develop. Before mass-production industries can expand, the machine tool industry must furnish the tools.

During the twentieth century the machine tool industry has experienced remarkable fluctuations in production. The first great impetus to production came with World War I, when output rose from about $30,000,000 in 1915 to a peak of $212,000,000 in 1919. Since machine tools normally have a life span of 20 to 25 years, the surplus tools of World War I had a depressing effect on the machine tool industry until the late 1930's. With world rearmament in the middle and late 1930's production expanded. Annual output increased from about $55,000,000 in the early 1930's to $185,000,000 in 1937. From 1935 to 1937 about 20 per cent of all tools produced were exported, and between 1938 and 1940 about 40 per cent.

Machine tool needs ballooned during the early war years under the exigencies of military production requirements. Value of production increased from $440,000,000 in 1940 to a peak output of $1,322,000,000 in 1942, an almost sevenfold increase over the sales of 1939. Production of machine tools had so thoroughly filled war demands by 1942 that output declined to $1,180,000,000 in 1943 and to $497,000,000 in 1944. Employment in the machine tool industry increased from 36,600 in 1939 to a peak of 122,000 in 1942. From January 1 to July 1, 1942, 773,779 machine tools were shipped from plants to consumers, more than in the previous 20 years. These shipments were equal to 45 per cent of the total number of tools operated by the nation's metalworking industries or 1,711,137 tools. It is estimated that 18 per cent of the tools produced during the war were exported.

Although machine tool output declined temporarily at the close of World War II, production in recent years has exceeded all previous peacetime totals. Annual output since 1951 has varied from $700,000,000 to $1,500,000,000. A number of trends are discernible in the American machine tool industry. Because the cost of producing machine tools has risen sharply and because foreign competition has become increasingly great, emphasis has been placed, not only on improving existing tools, but the development of new tools for greater efficiency. The automobile, aircraft, missile and agricultural machinery industries have been most active in advancing the machine tool industry, since these four activities use more than three-fourths of U. S. machine tool production. The need for continuous improvement in operating economies is great in mass-production industries because the economy of

producing a single piece is multiplied by the number of pieces produced.

The need to reduce the cost of American machine tools has resulted in increased automation. There are also increasing attempts to standardize machine tools. Machine tool users, until recently, often were obliged to purchase machines constructed to perform a specific job, such as producing a particular part for a given car model. When the job was finished the costly unit had to be scrapped or at best stored for possible future use. Today much of this waste is being eliminated because a fast-widening segment of the machine tool industry is adopting a construction concept known as the "building block" technique. This enables a machine tool user to convert his unit to perform an entirely new job by simply replacing its metal forming tools and the gadgets that hold and position them.

The most significant advance in the machine tool industry in recent years has been the numerically controlled tool developed by the Massachusetts Institute of Technology between 1952 and 1957. In order to operate this machine tool the first step requires that a general purpose computer take an instruction, such as "cut a circle with a five-inch radius at two specified points" and decide all the separate tool positions, perhaps running into the hundreds, that are necessary to perform the operation. A punched tape is then prepared to direct the machine tool control system. The numerical system is likely to revolutionize the machine tool industry in the immediate future. It is estimated that savings of 50 to 90 per cent on production costs are possible with numerical machine tools. This is a saving of impressive magnitude that can offset the rising cost of American machine tools.

With the new advancements, it is increasingly desirable for the machine tool industry to be localized near its market. The industry will continue to be closely allied with the machine building centers. With the high efficiency of new numerical tools and the ease with which they can be programmed, American machine tools become increasingly competitive in the world market. Numerical tooling is revising concepts of design, inventory, computing costs, drafting practices, and production schedule methods. This is not a refinement of an existing method, but rather the molding of electronics, metal cutting, electrical engineering, and computer technology into a really new approach to an old problem.

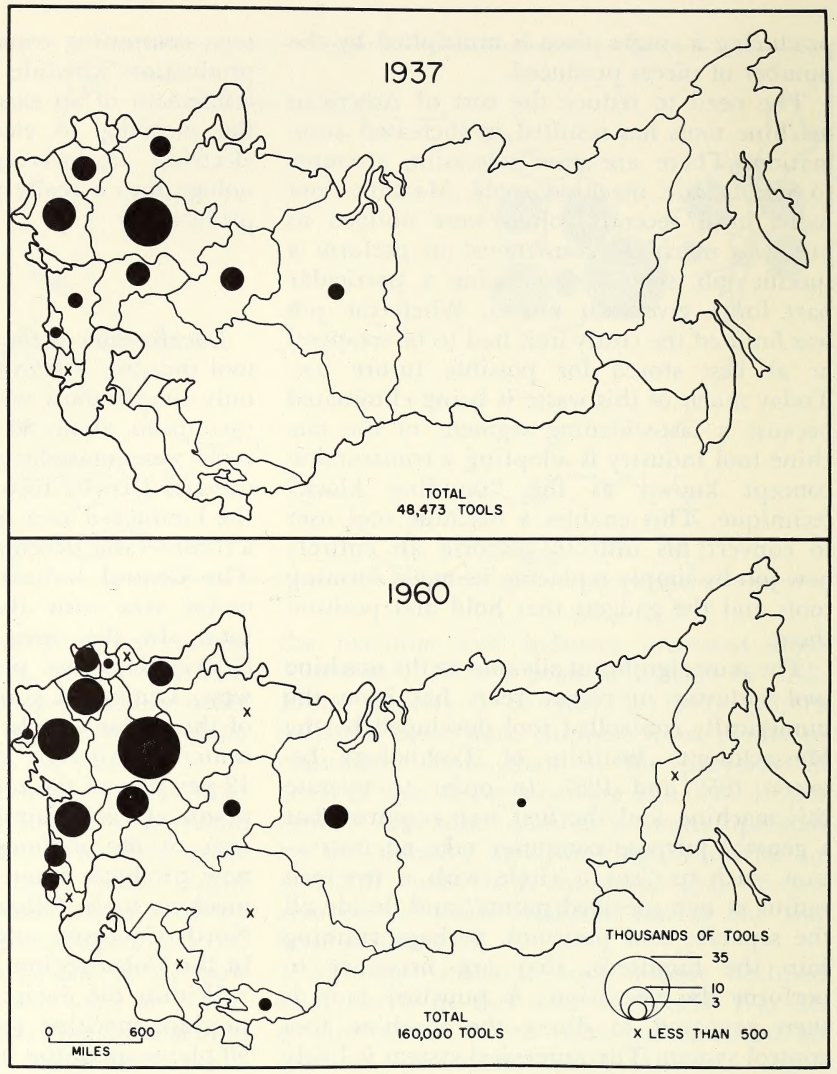
SOVIET UNION

Localization of the industry. The machine tool industry developed in tsarist Russia, but only simple tools were produced. Before the revolution, about 80 per cent of the machine tools were manufactured in the Central Industrial District focusing on Moscow, and in the Leningrad area. Since 1928 there has been a considerable decentralization of the industry. The Central Industrial District remains the major area with about 30 per cent of the total. In this area Moscow, Ryazan, and Gorkiy dominate production. In the northwest, Leningrad produces about 5 per cent of the nation's tools. The Ukraine area, with centers at Kharkov and Kiev, produces about 12 per cent of the total. The Urals area, with plants at Chelyabinsk, has more than 10 per cent of the nation's production. Belorussia now produces about 10 per cent of Russia's machine tools, followed by 9 per cent in the North Caucasus, and more than 7 per cent in the Volga region.

Within the Soviet Union some 170 plants produce machine tools. It is estimated that 50 plants specialize in metal cutting machines, ten in metal forming machines, and the remainder in machine tools and other machinery.

Production characteristics. Since World War II the Soviet Union has placed tremendous effort on the growth of its machine tool industry (Map 9.3). The value of automation is recognized in the industrial progress of the nation. As Bulganin stated in 1956, "the economic effect of automation in engineering works is high. Our up-to-date production lines make it possible to reduce the number of workers between approximately one-fifth and one-tenth of what it was, and to curtail working time in processing to the same extent."

Although past efforts have been impressive,



9.3. Soviet Union — Machine Tool Production—1937, 1960.

the seven-year plan (1959-1965) places even greater goals in Russia's drive for world industrial leadership. It is intended to double the output of the machine-building and metal fabricating industry during the seven-year period. To realize this goal it is appreciated that machine tools must be produced not only in great quantity, but there must be a continuous improvement in quality. The goal calls for a rate of growth of two to three times the production of 1958.

The Russians have achieved a high rate of production. The largest Soviet machine tool builder, the Moscow "Krasny Proletariy" plant, produces more than 12,000 16-inch engine lathes a year by using conveyor line methods for the production of bases, beds, headstocks, and gears and by assemblying the machine tools on a moving conveyor. In recent years the United States has been producing about the same number of lathes as in this single Russian plant. Using assembly line techniques, the Odessa radial drill plant produces over 2,000 drills a year, or twice the United States output.

The Russians claim that it requires only 18 months to develop a new machine from the drawing board to production. The reason for this phenomenal rate may be due to three factors. The first is the driving force that

seems to impel all workers in machine tool plants to attain a greater and greater production volume. The second factor is the use of mass-production techniques such as the conveyor assembly system found in any up-to-date auto plant. A high degree of standardization of components is common to many types of machine tools. Standards have been applied to 85 per cent of the general purpose metal cutting tools and to 75 per cent of the presses and forge machine tools. Finally every major machine tool building plant is geared to build not only general-purpose tools, but also special ones. This dual-building concept accelerates the introduction of new models.

In addition to standard types of machine tools, the Soviets have built a number of prototypes of numerically controlled tools, including lathes, mills, drills, horizontal and vertical boring drills, and jig boxes. The majority of the metal-forming machine tools, however, are general purpose presses, hammers, shears, and bending machines. The quality and technology of Soviet machine tools vary considerably and workmanship ranges from poor to excellent. Materials are good and design is functionally adequate.

The Soviets have developed an intensive research program for the development of machine tools (5). A Ministry of Machine Tools establishes general policies of operation. The principal research organization, ENIMS, employs over 1,000 scientific workers, plus about 1,000 nonscientific workers. There are other institutes not so large, but employing totally 2,500 to 3,000 workers. Although machine tool builders have freedom in building special machines, all general purpose machines must be approved by the Ministry and ENIMS. There are a number of special schools to train new machine tool workers.

GERMANY

The German machine tool industry started shortly after the Franco-Prussian War in 1870. It developed with the expanding industrialization of Germany. Because there was only a small export of tools in this period the Germans had to produce them at home in order to grow industrially. By the end of the century the Germans had a significant tool industry. By 1910 it had surpassed the British industry in size and was second only to that of the United States.

World War I necessitated a tremendous growth of the German industry, and the German defeat did not affect the industry greatly. In the early 1920's Germany started an industrial expansion program, financed mainly on borrowed money. This was carried out between 1923 and 1928, and gave Germany an undisputed manufacturing position in Europe. The economic depression retarded industrial growth in the early 1930's, but a rapid expansion of the German machine tool industry began once again in 1933 and reflected both the rearmament policy of Hitler as well as a number of taxation reforms introduced in order to encourage the modernization of German industry and particularly the growth of the machine tool trades. Although the German machine tool industry was but 50 per cent that of the United States, it exported in 1937 nearly 20 per cent more. During the entire interwar period Germany exported machine tools to the European nations. The Soviet Union was usually the largest buyer, with Germany supplying between one-third and one-half the Russian imports.

In 1939 on the eve of World War II the German industry employed some 60,000 wage earners in about 150 firms. There were over 20 factories employing over 1,000 workers each, with the largest employing about 3,000. There were several firms that could build any type machine to the customer's design. Germany also had a large number of comparatively small shops producing special machines, such as slideways, grinders, and diamond turning lathes. The German industry was modern and progressive in every sense.

At the outbreak of World War II Germany had 1,177,600 machine tools in use as against 942,000 in the United States. From surveys, there is every indication that the number of machine tools steadily increased during most of the war. By 1945 Germany possessed more than 1,800,000 machine tools. When the war ended, Germany, in spite of the bombings, still had in reparable condition probably as many machine tools as were in the United States. During the war no more than 15 per

cent were damaged beyond repair. The maximum number of machine tools destroyed in 1944, the year of the heaviest bombing raids, was 36,000, and only 110,000 were damaged and repaired. Thus, in 1944 about 6 per cent of the existing tools were either damaged or destroyed. Only once did a single raid damage or destroy more than 5 per cent of the machines in a target area.

At the close of World War II the German machine tool industry was reduced to 11.4 per cent of its 1938 capacity by the Potsdam agreement. Production facilities were thus restricted to approximately 18,000 tools annually. Restrictions included not only quantity, but size and type. The remainder of the industry was to be removed and given to selected European countries as reparations. The Russians immediately made wholesale removal of production facilities in East Germany. The Allied powers controlling West Germany were more cautious of the destruction of the machine tool facilities. In 1949 production restrictions were relaxed and West Germany once again started to produce machine tools in quantity.

Manufacture of machine tools has been accorded top priority in West Germany. This industry is undoubtedly the most important single factor making possible the tremendous technical strides of the country. In 1961 approximately 10 per cent of all machines built in Germany were machine tools of one kind or another. The industry has had almost constant growth in the 1950's, but output has been greatly accelerated since 1957. In 1960 the German Machine Tool Association reported a production of $475,000,000 and a labor force of 86,000 in the machine tool industry. A labor shortage exists in the machine tool industry so that greater productivity is strongly stressed.

The machine tool industry of Germany is highly decentralized. No one area represents a critical key to the output. Decentralization of production was accomplished by establishment of a system of small plants. In the widespread distribution three regions stand out in importance. One major center of machine tools is located in western Germany in the Lower Rhineland. The principal centers of production are Dortmund, Cologne, Remscheid, Solingen, Düsseldorf, Duisburg, Rheydt, and München Gladbach. The area is associated with the heavy industrial region of the Ruhr. A second center is located in southwest Germany largely in the Neckar Basin as a result of the expanding machinery and automobile industry of that area. Principal centers of production are Stuttgart, Reutlingen, Göppingen, Heilbronn, and Karlsruhe. The third center in East Germany is located principally in Saxony and Thuringia. This is one of the oldest established industrial regions in Germany. The machine tool industry developed here at an early period to produce textile machinery. In later years a great diversity of industrial products was produced in the region and the machine tool industry expanded with a growing industrialization. The principal centers of production are Chemnitz, Ave, Lauter, Glauchau, Meerane, Gera, and Plauen.

SWITZERLAND

The Swiss machine tool industry developed in a different manner than in other countries. Switzerland is one of the leading centers for the production of precision instruments and watches, which require an accuracy in manufacture surpassing even that of normal machine tools. In recent decades there has been a growing world demand for good mass-produced watches. There has grown a like demand for machine tools sufficiently precise to make extremely accurate watch parts cheaply by machinery. The Swiss have thus created a large variety of especially high precision automatic machine tools. They have also gone further and developed some super precision machines for the building of high precision machine tools. As a consequence, the Swiss enjoy a virtual monopoly on high precision automatics, which has been maintained by the excellence and low price of their products. Although the Swiss machine tool industry is based primarily on peaceful pursuits, the Swiss military establishment is probably the only small state army which is almost entirely independent of the import of machine tools from the larger nations.

Although the Swiss machine tool industry

was well developed prior to World War II, it reached new production and development heights during the war. Switzerland has continued to maintain a strong competitive position in the European market. There are now about 45 plants producing machine tools, with 28 manufacturing no other products. Exports of machine tools average between 60 and 65 per cent of output, although some firms are shipping 90 per cent or more of their machines to other countries. The largest markets are European and South American countries and the United States.

The Swiss machine tool industry is situated in the northern portion of the nation. Major centers exist in the Jura Mountain area associated with the watchmaking industry. A second area of development exists in the Zurich District, associated with the machinery industry.

UNITED KINGDOM

The machine tool industry had its origin in Great Britain, where the primary tools were invented and developed prior to the middle of the nineteenth century. The geographical pattern of production for the industry was established early and has remained remarkably stable. At the present time one-third of the industry based on value of the product is concentrated in the Birmingham-Coventry area. This region furnishes one of the largest markets for machine tools in such industries as automobile, electrical equipment, and machinery. Manchester with 25 per cent and northeast Yorkshire with 20 per cent of the industry are traditional centers of production. The industry prospered early in these areas as a result of the demands of the textile industry for machinery. Of the remaining 22 per cent approximately one-half is found in the Scottish Lowlands and half in the London area.

The British machine tool industry in value of production and invested capital is one of its smallest industries (1). As in the United States the production curve of machine tools is closely related to general economic conditions. In 1936 the value of machine tools produced was about $33,000,000. As the world rearmed in the late 1930's British output increased to $85,000,000 in 1939 and continued to rise to a wartime peak of $240,000,000 in 1942. The number of wage earners increased from 25,000 in 1937 to approximately 85,000 in 1942. The growth of machine tool production was largely obtained by subcontracting to firms in other less essential, branches of manufacturing. Since 1950 production has varied from more than $100,000,000 to $265,000,000 annually.

The British machine tool industry exhibits characteristics of economic maturity. The United Kingdom is recognized throughout the world as an excellent producer of standard machine tools of all categories. It supplies almost the whole of home demand for such tools, and exports about 30 per cent of its production. Although the demand for standard machines has remained high, it has not increased as rapidly as demand for more complex types. The concentration on the production of standard machine tools accounts for the shrinking share of British exports in an expanding world trade and for the high proportion of machine tools imported by Britain. German tools are constantly sold to Britain, but British tools are rarely sold to Germany.

The emphasis on the standard types of machine tools in Britain stems from a number of problems. The bulk of the machine tool firms are private, established concerns, in which the management is not appointed but inherited. In many instances the first generation of owners became successful because of one or two clever inventions. This is particularly true in the Yorkshire area, where the average firm employs fewer than 200 workers and has a capital investment of about $100,000. In recent decades there have been few advancements developed by the British industry as compared to American or German accomplishments. This is largely because of the high cost of research in the machine tool industry. At the present time the development of a single tool such as a multispindle automatic may take several years and cost $100,000 in the design stage and a further $500,000 or more for jigs and tools to ensure its economic production in quantity. Small firms cannot risk their entire capital in the hope of

acquiring a new machine. A large number of the firms rely on the skill of their workers and the tradition that their tools will be satisfactory. In recent years there has been a growing dependence on licensing agreements to manufacture machine tools of foreign design and a reluctance to meet the special needs of particular customers.

The greatest single need of the British machine tool industry is for an increase in research and development by qualified engineers. During World War II there were some technical improvements in design and in method of production. However, no significant changes were possible due to control of design by the Ministry of Supply. In recent years the Machine Tool Trade Association, the Department of Scientific and Industrial Research, and other agencies have prepared recommendations to insure the maintenance of a sound industry. The recommendations include establishment of government-owned pilot plants to conduct research and develop the most efficient machine tools possible; encouragement by the government of the production, even on uneconomical terms, of machines which are at present supplied from abroad; and an increase in the funds for research and development. Nevertheless, progress has been moderate. The present annual rate of research and development of less than $10,000,000 is considered inadequate. There is also a growing shortage in the industry of skilled workers. The future of the British machine tool industry is not promising.

JAPAN

Japan was the first producer of machine tools in the Far East. The industry grew rapidly as Japan prepared for war in the 1930's, and by the middle of the decade the Japanese were able to reproduce exact duplicates of many automatic American machine tools. The number of wage earners increased from 1,920 in 1931 to 76,000 in 1939, and the value of output multiplied at about the same rate. The peak year of prewar production was 1938, when 67,260 tools valued at $204,000,000 were produced.

The geographical pattern of the industry was established in the 1930's. The Japanese industry was built to supply tools for the armed forces, and consequently the industry was fairly widely distributed to prevent easy destruction by bombing attacks. However, all machine tool centers are associated with machinery producing areas. The Tokyo region is the major center of production, but other important centers include Nagoya, Kusunoki, Osaki, Kachigawa, Karatsu, Niigata, Nagaoka, and Yokohama.

The machine tool industry produced at near capacity throughout the World War II period. Peak employment was reached in the industry in 1943 with 126,000 wage earners, and maximum value of production of $723,378,000. It is estimated that less than 10 per cent of the machine tool plants were damaged or destroyed by aerial bombings.

At the conclusion of the war there were several recommendations to limit machine tool production. The Pauley Reparations Mission recommended that about 50 per cent of the tool capacity of Japan be destroyed, and the excess be distributed to neighboring nations, particularly China. In May 1946 the Far Eastern Commission recommended that Japan be limited to a capacity of 27,000 units annually. In addition, it recommended that all machine tools in industries constituting a war potential, including aviation and steel, be removed leaving only those for peacetime operation. In 1946 available estimates indicated Japan had about 1,100,000 units of tools.

In the early postwar years the machine tool industry of Japan did not recover, although restrictions were soon relaxed. Because of heavy production during World War II and the disappearance of the demand for munitions, the industry had difficulty in disposing of existing machine tools. There was also little capital available for modernizing existing plants. To further depress the industry, 220,000 units of machine tools designated for reparations were released to Japanese industry. Because of these economic and political problems, the quality of Japanese machine tool production declined. The predominance of small, simple tools characterized early Japanese postwar production. As a result Japan had to import the more complicated machine tools. From a peak of 446 companies at the

time of World War II, the machine tool makers declined to a low of 21 companies in 1951. Many machine tool producers converted to other types of manufacturing during this period.

Beginning in 1951 the machine tool industry began its recovery. The reason for the expansion was that the old tools were wearing out and were also becoming outmoded, causing the domestic market to increase. To encourage the rehabilitation of the industry aid has been given in a number of ways. Foreign technical aid, particularly from the United States, Switzerland, and France has improved the quality of Japanese machine tools. The Japanese government has also provided a protective tariff for those types of machines produced in Japan. This allows only noncompetitive machine tools to enter the country.

Although strenuous efforts were made to revitalize the machine tool industry, its progress was relatively slow until 1957. At that date production was still 14 times less than the peak of World War II, and ten times less than pre-World War II output. Japan was still importing between 50 and 60 per cent of its machine tool requirements. There were many reasons for the lag in output. Japanese metalworking firms lacked capital to purchase new, expensive machine tools. There was also an excessive competition among Japanese tool builders, thus limiting profits. At times competition from foreign countries discouraged the domestic industry. Resistance of Japanese labor unions to the installation of machine tools that might replace workers was marked. Finally, many Japanese industrialists did not believe that production benefits offset the large outlay of funds required, especially in view of high interest rates and an abundant, cheap, and skilled labor supply.

In the late 1950's the Japanese standard of living and mode of life were changing rapidly. The economy was evolving on a pattern similar to that of the Western industrial nations. The machinery needed for the transition created a high demand for machine tools. By 1960 the output of machine tools was five times that of 1955. There are more than 85 machine tool producing firms of which 30 have more than 200 employees each.

MINOR COUNTRIES

Since the conclusion of World War II there has been a fairly significant rise in production in the minor machine tool producing countries of Europe. Industrial expansion has created a fairly large demand, and the desire to be self-sufficient has encouraged production. Some countries are also attempting to gain an export market.

Sweden's metalworking industry has been producing at near capacity since World War II. Prior to World War II there were less than a half dozen machine tool factories in Sweden. Between 1939 and 1943 the value of machine tool production rose 300 per cent. There are now about 30 machine tool manufacturers in Sweden of which the largest firms employ about 750 wage earners. The major tool centers, all in the southern portion of the country in the industrialized zone, are located at Arboga, Köping, Lidköping and Rosenfors. Sweden has developed a small export market largely with western European countries.

Although the Belgian machine tool industry had its beginning in the middle of the last century, it has had a rather limited development. The impact of the destruction of the Belgian industry in the First World War and the 1930 economic depression affected the industry adversely. During the 1930's a broad program of reorganization and development resulted in a system of specialization, whereby each firm more or less voluntarily narrowed its line of products. Thus, it became possible to assemble certain types of machines in fairly large quantities, and in this way to achieve the economies of larger scale production.

During World War II the machine tool industry of Belgium continued to operate, and at the conclusion of the war gained part of the market originally supplied by Germany. The Belgian industry has been producing at near capacity since 1950. Annual output has increased from 10,000 to about 15,000 units. The industry is composed of 12 principal companies and about 20 smaller ones, with a total of more than 5,000 wage earners. These companies are concentrated in the Sambre-Meuse industrial district. Approximately 80

per cent of the production enters international trade.

France normally supplies about one-third of her needs in machine tools. Although French engineers produced some notable advancements in machine tooling during its developmental period, advancements have been relatively minor in recent decades. France has, however, revitalized her machine tool industry since 1950. The principal objectives are: (1) the maintenance of about 600,000 usable machine tools and (2) the replacement of the oldest units with new machines. The replacements come approximately one-half from domestic production and one-half from imports. There are at present about 35 machine tool works in France with about 10,000 wage earners employed in the industry. The industry is concentrated in Paris and the machinery producing areas, such as the North.

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CHAPTER TEN

MOTOR VEHICLE INDUSTRY

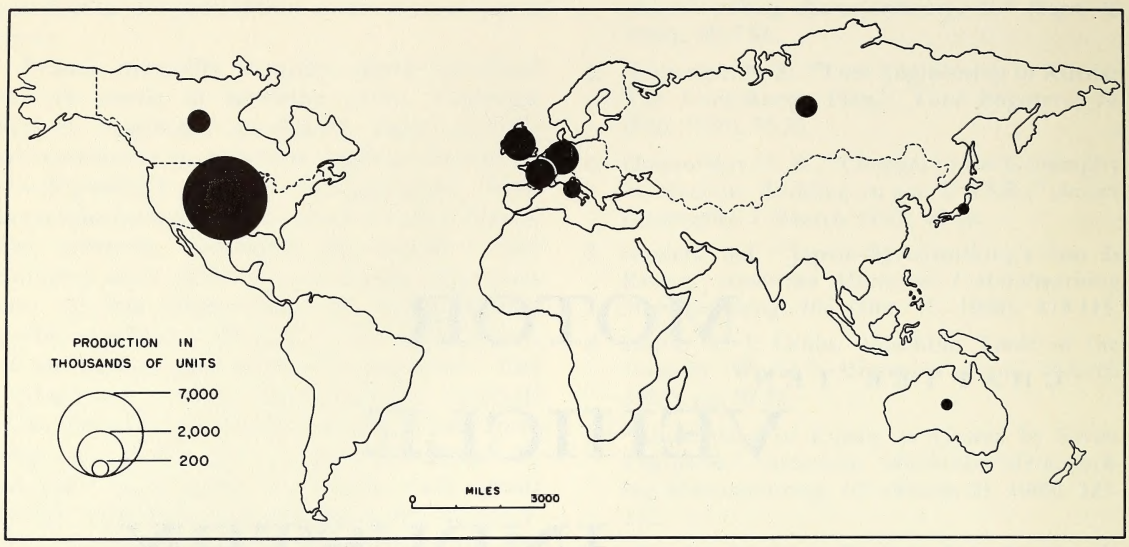
The development of the motor vehicle industry has taken place essentially within the twentieth century. From a position of minor importance in 1900 it has become the best example of the use of mass-production techniques to make quality products in great quantity. It is doubtful if any single industry has had so great an influence on the economic development of this country.

Out of a world total of more than 120,000,000 motor vehicles in all countries in 1960, the United States possessed over 75,000,000. The five next most important countries were France, 7,300,000, Great Britain 6,500,000, Canada 5,000,000, Germany 4,500,000, and U.S.S.R. with 3,800,000. If the number of motor vehicles in a country is considered in relation to population, the United States has one vehicle for 2.4 persons, Canada one for 3.2 persons, France one for 7.1 persons, Great Britain one for 8.3 persons, and Soviet Union one for 66 persons. China has fewest vehicles in relation to population with one motor vehicle for every 5,900 persons in the country.

WORLD PATTERN OF PRODUCTION

Prior to 1900 the western European nations, particularly France and Germany, led in automobile production. However, after 1900 the European countries quickly lost their supremacy to the United States, which has maintained undisputed leadership since 1905, with an annual output of 50 to 80 per cent of the world's motor vehicles (Map 10.1). When Canadian output is included with the United States the total percentage rises from 55 to 85 per cent. Although U. S. production has varied from 1,370,000 to over 9,160,000 vehicles annually since 1930, no other nation has ever produced as many as 1,800,000 vehicles in a single year. Nevertheless, the relative position of the United States has declined greatly in recent years with the growth of the European motor vehicle industry.

The United States has ideal physical and economic conditions for the development of a motor vehicle industry. In 1900 the country was a continental area relatively poorly served



10.1. World—Motor Vehicle Production—1960.

by railroads or other transportation. In a country that was expanding rapidly the automobile —a new and inexpensive form of transportation—was universally accepted. The United States also possessed resources well adapted to the development of the industry. American manufacturing is based on labor saving, large-scale production techniques. The goal of this country thus has been to produce a cheap, standardized car with good serviceability. The huge home market has given the American manufacturer many advantages. The large demand enables him to manufacture a car which is lower in price than any of the same class produced in other countries. The United States has continually been among the world's largest exporters of automobiles. Because a standardized car is produced, it is also easier to supply parts abroad. Furthermore, in those countries which provide the largest export market for cars, such as in Latin America, motoring conditions are similar to those in the United States rather than Europe. The American car is better adapted to rough roads than the small European vehicle.

Outside the United States and Canada, the European nations, including the U.S.S.R., produce 30 to 40 per cent of the world's motor vehicles (33). As a result of rapidly expanding production, the European nations have greatly increased their share of world motor vehicle production. In Europe, West Germany became the largest producer, surpassing the United Kingdom in 1956 and now produces about 15 per cent of the world's total. West Germany's motor vehicle industry was limited by controls until about 1949, but grew rapidly in the 1950's. Production rose from 304,900 motor vehicles in 1950 to over 1,700,000 in recent years. The United Kingdom is the second largest producer of motor vehicles in Europe with an annual output of over 1,500,000. France with an annual output of 1,280,000 vehicles is the third largest European producer, with about 10 per cent of the world's output. The Russian motor vehicle industry has been expanding rapidly in recent years. Annual production is over 500,000 vehicles, of which approximately two-thirds are trucks. This gives the U.S.S.R. the fourth largest vehicle industry in Europe and the fifth largest in the world. Italy has a growing automobile industry, with a production that has varied from 30,000 to over 500,000 vehicles annually in the past two decades. Small producers and assemblers of motor vehicles in Europe include Czechoslovakia, Austria, East Germany, Finland, Hungary, the Netherlands, Spain, Poland, Sweden, Yugoslavia, and Romania.

In recent years a motor vehicle industry

has developed in a number of countries outside Anglo-America and Europe. The Japanese industry has expanded rapidly and annual output is about 50,000 vehicles. Mainland China has established a motor vehicle industry, but production is small and primarily limited to trucks. In Latin America a domestic motor vehicle industry is growing in Brazil and Argentina. Australia has a well-developed automobile and truck industry. In a number of countries the assembly of foreign vehicles has become significant. These include Australia, Mexico, Venezuela, Brazil, India, Indonesia, Israel, New Zealand, Philippines, and the Union of South Africa.

UNITED STATES

The automobile and the American economy. The automobile has played a dominant role in shaping the economic growth of the American nation. The United States Department of Commerce data indicate that one out of every six businesses is automotive in nature. The American Automobile Association reports that 10,460,000 persons— or about one of every seven employed persons in the nation—work in industries connected with motor transportation. This includes 790,000 in the manufacture of motor vehicles, 294,000 in the crude and refined petroleum industry, over 200,000 in automotive sales and services, 490,000 on state, county, and local road crews, 6,560,000 as truck drivers and others connected with the automobile industry, and 300,000 in motor, bus, and taxi employment.

Because the automobile industry is the largest consumer of raw materials and partially manufactured products, it has been responsible for the development of many new industries (9). Of these, none is more important than the petroleum industry. Before the automobile, gasoline was considered practically worthless, and refineries often disposed of it by dumping it into streams. The modern oil industry began with the introduction of the internal combustion engine. Crude oil production in the United States has soared from 63 million barrels in 1900 to over 2,500,000,000 barrels in 1960, and the automobile industry consumed 80 to 85 per cent of this output.

The magnitude of the auto industry is demonstrated by its annual purchases. It provides a market for 17 per cent of all steel consumed in the United States, about 50 per cent of the malleable iron, 63 per cent of the rubber, 43 per cent of the lead, 63 per cent of the leather, 70 per cent of the plate glass, and 12 per cent of the copper. Materials needed for the construction of the automobile are brought from nearly every country in the world. No other industry requires so wide an assembly of materials on so mammoth a scale. Besides the obvious requirements, such as steel, rubber, and glass, the auto manufacturer buys such unusual items as ground corn cobs for use as a base for a polishing compound, pipe cleaners for cleaning small holes, razor blades for cutting insulation and cartons, baby-bottle nipples for covering certain parts as they go through paint spraying booths, cactus fibers used in air cleaners, and walnut shells used in polishing operations.

The business experiences of many of the automobile industry's suppliers provide fascinating accounts of American enterprise motivated by the diverse requirements of motor vehicle manufacturers. In Oakland, California a firm was organized by a man and his wife to make "shims," tiny pieces of metal used to level the fit of a car body to its chassis. The firm had four employees when it got its first automotive order, but now manufactures 45 different parts and has an annual sales volume of more than one million dollars. In Milan, Michigan two doctors who hoped to make their little town more prosperous established a small plastic firm in 1946 with nine employees. Orders from the auto industry helped it grow to a flourishing enterprise with 255 employees, a fifth of Milan's working population.

Although the automobile is one of the youngest of American industrial giants, it greatly surpasses such industries as meat-packing, shipbuilding, and cotton and woolen textiles. Factory sales of motor vehicles in 1959 totaled 6,728,644, including 5,591,243 passenger cars and 1,137,401 trucks and motor coaches. These automotive products had a combined wholesale value of $12.8 billion. Replacement part sales totaled $2.2 billion. Since 1930 the value of automobiles, parts, and accessories has usually ranked first in

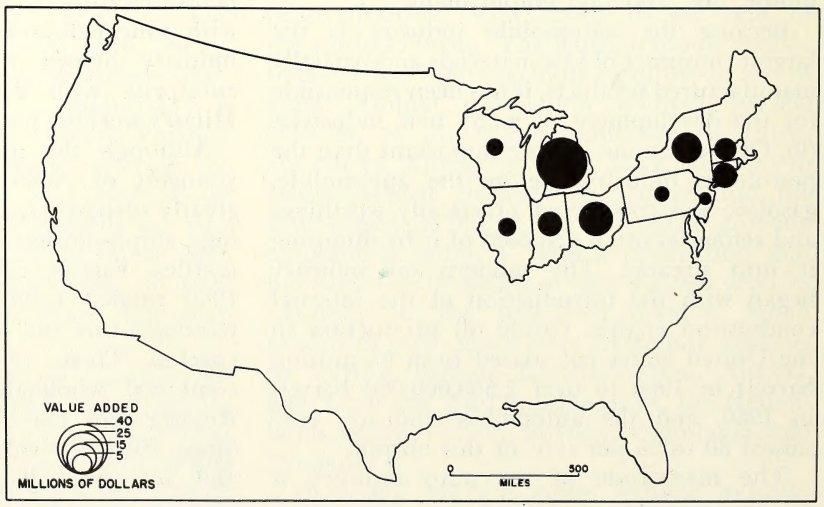
export of manufactured goods. The automobile industry and its products provide more than one-tenth of the taxes to all forms of government in the United States. Because of the needs of the automobile, over three million miles of improved roads have been built in this country, about 40 per cent of all the paved roads in the world.

Early localization. The automobile industry from its earliest period was concentrated in the lower Great Lakes states. In 1909 when the industry first appeared in the U. S. Census of Manufactures, this region had over 70 per cent of the total production, Michigan being dominant with about 35 per cent of all output based on value added by manufacture (Map 10.2). New York was the only important producer outside the midwestern states.

A group of factors was influential in the development of this early centralization (5). The lower Great Lakes states had a number of existing industries directly related to the growth of the automobile industry. This region, with its hardwood forests of oak, hickory, and maple, was the most important area of buggy and carriage construction in the country. Because the early automobiles were essentially buggies with a motor attached, the horse-drawn and horseless carriages were similar in many ways. As a result of the growing lake-freighter transportation, this area had become an important producer of gasoline and steam engines for stationary power uses. Within the area there were also developing agricultural machinery and diversified metals fabricating industries, which became basic in supplying the automobile assembly industry. Most of these industries were not integrated, but comprised large numbers of independent enterprises. As a consequence, inventive and manufacturing talent familiar with machine techniques and factories with the physical facilities and a background of parts manufacture were readily available to supply the automobile companies.

Largely as a result of the above factors there were many pioneer inventors and manufacturers in this area. Since this was a new and expanding economic region there were also a number of men willing to risk capital and energy in the new industry. It is also important that the initial success of the automobile occurred in this area while most of the eastern areas were having discouraging failures. Since the growth of the leading producers was cumulative, the automobile industry soon became centered in the lower Great Lakes location. The topographic factor cannot be disregarded. Although much of the East is hilly, the Central Lowlands are relatively flat, and since the early cars had little power this was one of the best areas in which they could function successfully. Long distances created by the great land areas of the United States and poorly developed public transportation also stimulated the new industry.

Detroit and the Ford Motor Company. As the automobile industry concentrated in the



10.2. United States — Motor Vehicle Production—1909.

lower Great Lakes states, the Detroit area from a very early date became the leading center of production. The first important factor localizing the automobile industry here was the ability of the Olds Motor Works to produce a successful car in 1899 at East Lansing on what was then a large scale. The Oldsmobile was possibly the earliest car to make a profit for its producers. This car demonstrated that the automobile could be built and sold in quantity and a profit made in its manufacture. The Michigan people were really the first in the United States to become automobile-minded.

This early success had a number of important implications. It caused a group of early inventors and developers to be attracted to Detroit, such as David Buick, Charles King, Henry M. Leland, and the greatest of them all, Henry Ford. Detroit was soon the center of new ideas for producing a better automobile.

By 1903 when the Olds Motor Works was producing 4,000 cars annually, Detroit became the motor capital of the world. Dozens of new companies began to produce cars here. All of these, however, remained small until Henry Ford applied mass-production methods, which gave industry substantial size and assured Detroit of undisputed leadership (7). The basis of the Ford car was the idea of cheap interchangeable parts. As an old part wore out a new part replaced it, so that theoretically at least the buyer needed only to purchase a car initially and could keep it in running order indefinitely by replacing parts.

In order to produce this new car, Ford revolutionized the techniques of automobile manufacturing. Standardization was the key to Ford's mass-produced automobile. This was accompanied by the use of highly specialized machine tools, power driven conveyor assembly belts, minute subdivision of labor, intensive supervision, and high wage rates. In Highland Park, Michigan in 1909 one of the world's largest manufacturing plants was erected. In the new plant the company introduced innovations in factory and shop practice that gave Ford undisputed leadership in the automobile industry for nearly two decades. This method, which is now used by nearly all assembly industries, is known as the "endless chain production system" (26). In the traditional factory, machines were located in groups according to the type or class of operation. This resulted in a large amount of crisscrossing of the lines of movement and much in-shop transportation. The Highland Park plant was designed to avoid this by having the machines and the employees operating them placed in such sequence that the automobile was completely constructed as it moved from the beginning to the end of a single assembly line. Although this continuous process method had been used by steel companies, Ford pioneered in applying the system to the manufacture of such complex mechanisms as automobiles.

In close correlation with this method was the minute subdivision of the labor made possible by the development of specialized machinery designed to perform a specific operation in making the respective parts of a car. Tasks previously requiring skilled workmen were divided into many operations, skill in any one of which could be acquired in a few hours. The importance of this practice is appreciated when it is recognized that the existence of a large class of skilled mechanics and woodworkers in various localities early influenced the location of the automobile factories. The scale of the Ford operation would have been impossible had it depended upon existing skilled labor. The success of the Ford Motor Company caused the copying of its techniques by all large motor vehicle companies in the Detroit region.

All automobile companies outside the lower Great Lakes region have failed, and no new company has ever developed in another area. The General Motors and Chrysler corporations were formed from smaller successful companies in the area. The phenomenal success of one company in the early period became the magnet around which other companies developed.

Production characteristics to World War II. Prior to 1909 the growth of the automobile industry was comparatively slow. This was the period of initial experimentation and demonstration of the serviceability of the horseless carriage to the general public. Although every car in this early period had serious mechanical defects, all manufacturers tried to improve their product. The serviceability of the automobile was shown in many ways. One of the

most common of these was for a company to build racing cars, which toured the country's race tracks. Another common method was the sponsoring of cross-country trips and races. For example, the Oldsmobile displayed at the 1901 automobile show in New York City was driven from Detroit to New York, at an average speed of 15 miles per hour.

When the automobile became mechanically more dependable, the general public began to accept it as a practical means of transportation. But other factors helped stimulate the acceptance of the automobile. There was, for example the satisfaction derived from simply possessing a car, and the owner usually gained much social prestige within the community. The automobile could satisfy an individual's love of movement and give him independence to travel whenever and wherever he wished. Thus, in the short space between 1900 and 1907 the automobile changed from a simple motorized buggy to a rather satisfactory touring car, the forerunner of our modern automobile. Production during the same period rose steadily from 7,000 cars in 1901 to 44,000 in 1907.

The great growth of the automobile industry came with the introduction of the Model T by Henry Ford. Between 1908 and 1923 the Ford Motor Company dominated automobile production by producing more than half of the United States' output. Ford's annual production rose from 10,000 cars in 1909 to a peak of over two million in 1923. It was during this period that the car became a necessity for the average American family. Although at the beginning of World War I in 1914 there were about 1,700,000 registered automobiles in the United States, by 1922 there were over 10,700,000 cars on our highways.

The Model T was an ideal car for nearly a decade and a half, but the car owner of the 1920's became more discriminating in his demands. Engineering advancements such as the self-starter, the manual gear shift, and an inexpensive roof to enclose a car had been achieved by other producers but were not part of the Model T. The Ford had no change in body styling or chassis between 1910 and 1925. Also, by the 1920's there were more people living in urban areas, and our principal highways were so improved that the car became a style product rather than simply a rugged utility vehicle.

The Ford Company was faced with strong competition for the first time in its history. The General Motors Corporation, organized in 1908 and later absorbing Buick, Chevrolet, Oldsmobile, and Pontiac, introduced many improvements. This company also produced a complete line of cars from the lowest to the highest price level. Since the 1920's was a period of prosperity, G.M. had a car to suit every family budget. General Motors rapidly expanded its production in the 1920's and in 1927 became the leading automobile manufacturer with about 40 per cent of the total output. In 1924 Walter Chrysler organized the Chrysler Corporation by consolidating the Chalmers and Maxwell companies. Although it was a latecomer in the field it prospered from the start and by the late twenties was the third major producer. By 1925 Ford's sales were dropping rapidly and it was decided to discontinue the Model T and produce a new car. As a result of a complete retooling operation, taking over a year and a half, the Model A appeared in 1927, and Ford recouped much of its lost market. The Big Three were producing about 75 per cent of the automobiles in 1929 when a peak of 5,358,000 vehicles was reached by the industry. This number was not attained again by Detroit until 1947, nearly 20 years later.

The depression of the 1930's caused a drastic decline in automobile production. The low ebb was reached in 1932, when only 1,370,000 vehicles were produced. During the depression many people who had regularly changed models every year were forced to keep the same car for several years. At the same time the supply of used cars selling at low prices was large. Consequently, the early 1930's was a period when only the most progressive producers were able to survive. By 1932 the Big Three were producing 90 per cent of Detroit's automobiles. In 1929 the U.S. Census of Manufactures listed 40 passenger vehicle companies. By 1935 only 17 of these companies remained, and this number decreased to 11 by 1939.

By the mid-1930's many of the older cars were wearing out, and replacements were

needed. As a result the automobile industry was one of the first to make a major recovery from the depression. It in turn helped other industries recover. By 1935 production had risen to over 3,900,000 vehicles and the larger companies began modernizing their plants. In that year General Motors spent $50,000,000 on plant expansion and the Ford Company enlarged its rolling mill and steel plant at River Rouge. Until World War II—with the exception of 1938—production was kept at a high level, reaching a peak of 4,840,000 vehicles in 1941. Because of the demand for war goods, production of civilian automobiles was stopped from 1942 to the conclusion of hostilities in 1945.

Factors of decentralization. While the automobile companies were establishing their main plants in the Detroit region, they were also establishing branch assembly plants throughout the United States. This geographic structure developed as a result of the tremendous growth of the industry. The large manufacturers soon discovered that a single plant could not satisfy the demands of the country. The Ford Motor Company was the first to start this trend with the establishment of a branch plant in Kansas City, Missouri in October 1910. All other major producers now have branch plants strategically located in market areas throughout the United States and many have plants in foreign countries. The automobile industry has thus come to be the prime example of a centralized-decentralized organization.

The development of branch assembly plants has many advantages. Transportation costs are minimized by shipping parts instead of finished automobiles, since freight cars can be more heavily loaded, carloads of parts receive lower freight rates, and standard box cars can be used instead of special cars. As the automobile industry is basically an assembly industry, parts made outside of the automobile region can be shipped directly to the branch plants, often saving freight charges. Another advantage is that stocks can be accumulated at the various assembly plants, economizing storage. The assembly plants also establish sources of supply in the area in which they are located, thus aiding business in the immediate region.

There is also a significant advantage in the distribution of both parts and finished automobiles. Dealers are supplied with finished automobiles and parts directly from these assembly plants. This practice greatly facilitates the physical distribution of the great volume of production. In essence, the individual companies have grown too large to be located at a single point of production.

General Motors—an example of centralized-decentralized organization. The General Motors Corporation illustrates effectively the modern geographic structure of an automobile company (Map 10.4). This corporation is the biggest, most profitable private manufacturing enterprise in history. General Motors has an annual output of about half of all automobiles built in the United States, as well as about 450,000 trucks, 2,200 busses, over 2,000 diesel engines, and thousands of other products such as refrigerators, jet engines, and oil burners. It employs directly over 620,000 wage and salary earners, and, indirectly, about 200,000 more in privately owned sales agencies. By spending about half of its gross income of nine to ten billion dollars on materials and services it gives employment to possibly 250,000 more. In order to produce this amount of manufactured goods the nerve center remains in the Detroit region, with a vast system of decentralized facilities. In its simplest terms, the General Motors empire consists of 126 manufacturing plants, 30 parts and accessory plants, 103 warehouses, 79 sales and 46 management offices, 489 dealerships, and over 19,000 retail dealers.

This organization makes possible the most remarkable assemblage of materials and parts in modern industry. For example, suppose a Chevrolet is to be assembled in Baltimore, Maryland at 9:00 A.M. on a Friday morning. For assembly of that car a frame must leave a plant in Milwaukee on Monday afternoon. Its axles leave Buffalo, its engine leaves Flint, Michigan, and its transmission leaves Cleveland the following day. On Wednesday its fenders are shipped from Philadelphia. Meanwhile other components are shipped from other places, all to arrive in Baltimore shortly before final assembly. The problem of assembly becomes even more complicated when it is remembered that for the Chevrolet alone there

are at least 14 body styles, 18 trim and color combinations, and five special equipment options. The complexity of making and delivering 1,600,000 to 1,800,000 of these cars in a year is appreciable.

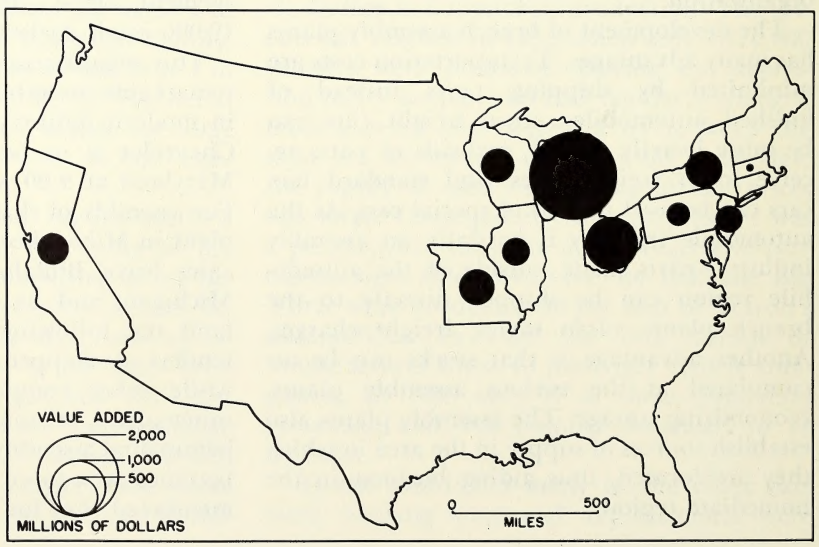
For years the automobile final assembly line, which can put together a completed car in two hours, has been popularly regarded as the industry's great miracle. The real miracle is the manufacturing and scheduling of all the car's parts to arrive at a certain point at a certain time. That accomplished, final assembly has become a comparatively simple operation.

American automobile industry in foreign countries. The American automobile has been accepted as a quality product throughout the world. In order to satisfy this market U.S. companies have developed world-wide organizations. The keynote of this system has been to make American-type cars available at the lowest possible price. Three methods have been used.

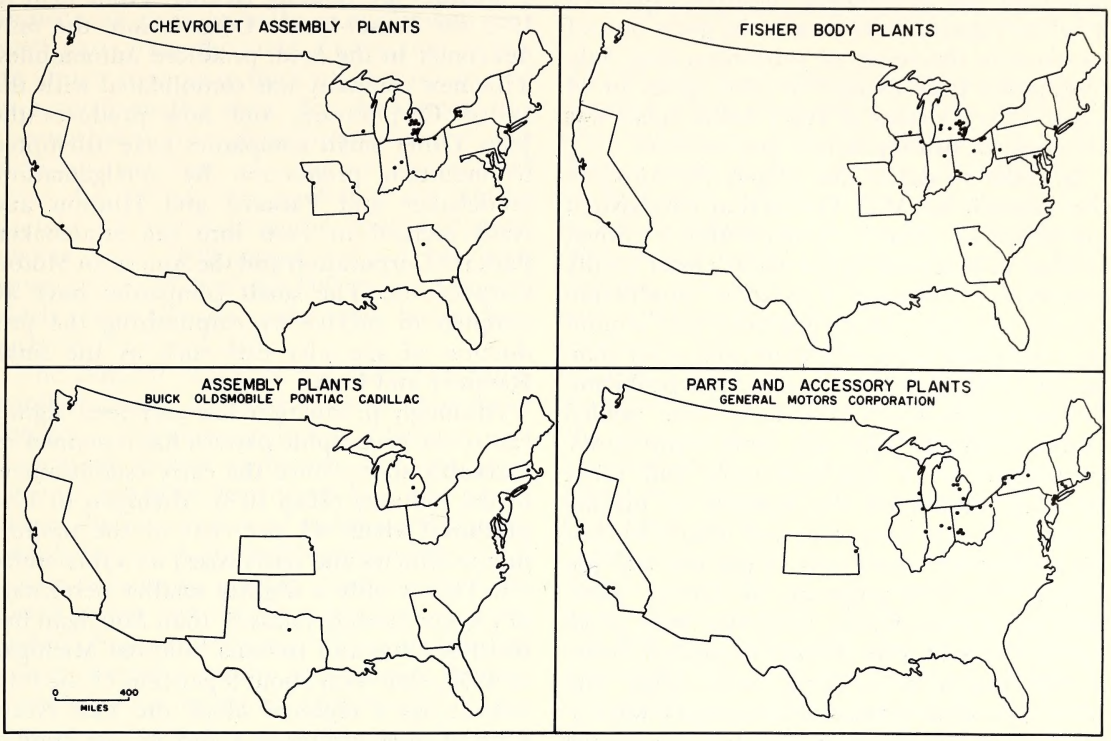
In countries with fairly large domestic markets branch assembly plants have been established. The development of overseas plants began in 1924 when Henry Ford built a factory in Copenhagen, Denmark to assemble the Model T. During the same year General Motors started operations at Hendon, near London, where Chevrolets were built. By 1925 General Motors had asembly lines functioning in Belgium, Brazil, Argentina and Australia, and, in 1926, in Germany, France, Spain, Uruguay, South Africa, and New Zealand. In areas where the market was too small to justify assembly operations, warehousing facilities have been established. The American companies have also developed sales services throughout the world.

In a number of countries the American-made automobile does not meet national preferences, or, because of high protective tariffs, American imports are in effect prohibited. In these areas where the market justifies development, American companies have purchased or constructed plants and applied American techniques of automobile construction. For example, General Motors in 1926 purchased the Vauxhall Motor Company in England and in 1929 bought the German firm of Adam Opel in order to produce a small car for the European market.

The development of overseas operations has many advantages. An important consideration is the possibility of delivering motor vehicles at the lowest possible cost. With an assembly plant at the point of destination, it becomes possible to ship both trucks and automobiles completely unassembled. A car, which represents 13 tons' worth of shipping space when standing on wheels, is reduced to three or four tons' worth of space when unassembled. American companies have also purchased raw materials and parts in foreign countries whenever possible. The degree of local purchasing



10.3. United States — Motor Vehicle Production—1958.



10.4. United States—General Motors Plants.

depends on the country. This not only reduces costs but integrates the overseas operations into the economy of the foreign country.

General Motors overseas operations illustrate the importance of this portion of the industry (15). The company controls 20 assembly and seven manufacturing plants in 16 countries, as well as a global network of warehouses and branch offices. Foreign subsidiaries and branches employ about 60,000 workers. Overseas inventory normally totals over $70,000,000. Distribution is handled through 2,400 foreign dealers who sell about 400,000 cars and trucks annually. General Motors ships about 40 per cent of the motor vehicles exported from the United States and Canada. The General Motors overseas operations are a major division of the corporation.

Automobile industry and World War II. The automobile industry was the greatest producer of military supplies in World War II (27). The industry began to gear itself to the production of war goods in the late 1930's, and by December 7, 1941 had received contracts totaling more than $4,000,000,000. After Pearl Harbor the demands for military equipment increased so rapidly that it was necessary to discontinue passenger car production on February 10, 1942, and civilian truck production was greatly curtailed after May 31, 1942. All plants were cleared of civilian automobile building equipment and replaced with machinery for constructing planes, tanks, guns, and other war materials.

The output of supplies during the war years was truly phenomenal. From June 1, 1940 to August 16, 1945 at the conclusion of hostilities, the automobile industry produced over $29,000,000,000 worth of military supplies. It built 75 per cent of the aircraft engines, more than one-third of the machine guns, 40 per cent of the tanks and tank parts, 50 per cent of the diesel engines, and 100 per cent of the motorized units. Of the military equipment produced by the automobile industry, aircraft totaled 45 per cent of all deliveries.

Although the automobile industry expanded its plant capacity enormously, its great output was largely the result of subcontracting. Subcontractors were located in 1,375 cities in 44 states. Fifty-six cents of every dollar spent was allocated to subcontractors and vendors.

In order to secure this output the Automotive Council for War Production emphasized the following points: "Competition vanished in what in peacetime is the world's most keenly competitive industry. Executive, production experts and top ranking engineers met around the conference table with men from other companies tackling mutual production problems. Acting cooperatively, the companies pooled technical secrets with one time competitors, exchanged motor machine tools and other facilities, intensified the practice of placing orders with subcontractors, and jointly worked out production short cuts to get the war job rolling. Training programs for factory workmen and for mechanics to service their products in the field were sharply expanded. Automobile engineers working with Army and Navy specialists devised revolutionary ways of fabricating war goods in quantity, improving performance of war products and averting critical material shortages."

Present geographic structure. At the conclusion of World War II there was an unprecedented demand for motor vehicles and production increased from three million vehicles in 1946 to an all-time high of 9,169,000 in 1955. This growth pattern is due partly to the stoppage of production during World War II and the need for replacements, and partly to the high prosperity of the country. Demand was greater than production for several years and it was not until late 1948 that cars became relatively plentiful. With the outbreak of the Korean War, production of automobiles was curtailed temporarily with output depending on the availability of steel. Since 1955 production of motor vehicles has varied from 7,220,000 to 5,130,000, depending upon the economic conditions of the nation. Output in 1958 and 1960 was curtailed because of an economic recession.

Since 1946 about 95 per cent of the motor vehicle production has been concentrated in the Big Three companies. General Motors has produced 45 to 55 per cent of the output. New companies are notably lacking. From 1946 to 1952 the Kaiser-Fraser Corporation, the only newcomer in the field, produced automobiles. This new company was consolidated with the Willys Corporation, and now produces the Jeep. Other small companies have attempted to maintain production by amalgamation. Studebaker and Packard and Hudson and Nash merged in 1956 into the Studebaker-Packard Corporation and the American Motors Corporation. The small companies have attempted to survive by emphasizing the production of specialty cars such as the small Rambler and Lark.

Although production has increased significantly the geographic pattern has remained remarkably stable since the early establishment of the industry (Map 10.3). Michigan in 1958 produced about 41 per cent of the nation's motor vehicles and parts based on value added (5). This is only a slightly smaller percentage of the automobile industry than Michigan had in 1919. Ohio and Indiana followed Michigan in 1958, each with about 9 per cent of the total output. As a regional block the East North Central area produced about 83 per cent of the total output, followed by the Middle Atlantic states with approximately 12 per cent.

In recent years the only important change in the pattern of the automobile industry has been the growing development of assembly centers on the Pacific Coast. In 1940 the West Coast produced 380,000 cars, while in recent years factories have been geared to an output of over 700,000. Pacific Coast automobile assembly is concentrated in California. Chrysler, Ford, General Motors, and Studebaker-Packard operate plants in the Los Angeles area. Ford and General Motors also have plants in the San Francisco Bay area. There is a substantial parts manufacturing business in California. Although the Pacific Coast is a growing new center, in 1958 the area produced only 4.2 per cent of U.S. output of motor vehicles and parts.

CANADA

The Canadian automobile industry is closely allied to development in the United States. The first plant was built in Canada in 1904,

and the industry was developed, as in this country, by carriage makers, machinists, and small parts manufacturers. Production trends are similar to those in the United States except on a much smaller scale. Because Canada has a somewhat similar physical environment and economic structure to that of the United States, Canadians have preferred the American-type car rather than the small European models. Since 1950 annual output has been between 250,000 and 475,000 motor vehicles, which places Canada as the sixth largest producer in the world (40).

The original center of the Canadian automobile industry is found directly across from Detroit at Windsor, including Chatham and Tilbury. A second center at Oshawa, near Toronto, has been developed. This new center reflects the importance of market orientation. Canada has aided the development of her automobile industry by placing a high tariff on imported motor vehicles. As a result most of the United States producers have established branch assembly plants in Canada. Because Canada cannot supply all parts needed to produce an automobile, most automobile parts enter Canada duty free. However, the Canadian automobile manufacturers have been endeavoring in recent years to increase the amount of Canadian materials in vehicles by extending their own manufacturing operations (12). Consequently the motor industry has become increasingly interrelated with the economic life of the country. Although there are only a half dozen automobile companies, there are more than 220 plants in seven provinces which are supplying materials and parts.

Although Canada employs the same methods in automobile assembly as in the United States, her problems are frequently different than those encountered by the American companies. For example, the Chrysler plant in Canada produces four makes of cars on one assembly line. In the United States each make of car is produced in a separate factory. The Canadian system is necessary because of the limited output, which is about one-tenth to one-twentieth that of the United States. There are few branch assembly plants in Canada, since those in Ontario can supply the country's entire demand.

GENERAL CHARACTERISTICS OF THE EUROPEAN AUTOMOBILE INDUSTRY

The European automobile industry has many features which distinguish it from its American counterpart. Although standardization has been a part of the American industry from its beginning, individualism in the production of luxury vehicles is still important in Europe. This luxury industry is characterized by small volume, individual styling, choice materials and hand workmanship. The luxury cars are produced not so much in factories as in garages. There are no huge investments in mass-production tooling as in Detroit. With the production of the expensive hand tooled automobile, the Old World still keeps alive the romantic conception of the motor car as an individual work of art.

More important to the average European citizen, however, is the small automobile produced in quantity. These automobiles are one-half to three-fourths the size of standard American cars and are the type owned by the well-to-do middle class family. Although the companies try to copy Detroit's techniques, the limited demand still makes the small car expensive by American standards.

The use of automobiles and the development of the European industry have been limited for a number of reasons (2). The great majority of European families have a low per capita income. Since even the small automobile is an expensive product it can only be bought by a small percentage of families. The relatively low family income is the greatest factor limiting the development of the European automobile market.

Because the American automobile is relatively low priced, nearly all countries in Europe protect their industry with a high tariff. Although this shelters their domestic industry it prevents the citizen from acquiring a foreign-made automobile. Other factors which long retarded automobile manufacturing were the displacement of industry and the problems of reconstruction as a result of two world wars. Most countries in Europe place a heavy vehicle tax on automobiles, and gasoline is expensive. Finally, the European countries are small and are served by excellent railroad and waterway networks so that the

need for high-speed automobile transportation is less than in the United States.

GERMANY

Early developments. The motor vehicle industry developed slowly in Germany. Until the middle 1920's only luxury cars were produced in small quantities. The production of a small car for the middle class market was entirely lacking. In 1926 there were only 545,000 vehicles in the country, of which 237,000 were motorcycles. The motor vehicle industry was widely scattered throughout Germany. The emphasis on individuality of design and small production made the availability of mechanical labor the most important factor in localizing the industry.

In the late 1920's the German government encouraged the development of the industry by giving it a strong protective tariff. Small car production was begun on a limited scale. There was a gradual change from the handicraft system to the mass production of cars with large capital expenditures in the industry. Foreign capital was encouraged to enter the automobile industry. In 1929 the General Motors Corporation purchased the Opel plant at Rüsselsheim and planned to increase production of the small Opel automobile. However, expansion was sharply curtailed in the early 1930's as a result of the depressed economic conditions. As late as 1933 the automobile industry was greatly retarded in relation to other engineering industries. Germany had only one auto for every 90 inhabitants, in comparison to one for every 28 people in France.

Motor vehicle industry and the National Socialist Party. As was the situation with most industries in Germany, the automobile industry had a strong revival with the coming to power of the National Socialist Party in 1933. From this date production and development policies were controlled by the government. The fundamental objective was to increase the use of motor vehicles in the country. Production and domestic consumption were encouraged by many measures. The license tax on private motor vehicles was abolished for automobiles constructed after April 1933. A road construction program was begun in February 1933 to provide a modern highway system. The Reich Autobahn, which was basically a circular road around Berlin with radiating roads to border regions, typified this program, and constituted the backbone of Germany's military routes during World War II. An export market was encouraged with the aid of a government subsidy. The subsidies took the form of a fund created by a levy on all sales made by producers and dealers, and an exchange rate granted to exporters that was more favorable than the standard exchange rate of the reichsmark.

It was also the goal of the National Socialists to provide a small, cheap car similar to those in England and France. It was hoped that this would be best accomplished by the Volkswagen (People's car) which was to be produced by the government. The Volkswagen plant at Wolfsburg was not completed until 1939, and produced almost no cars for the German public. The growth of the industry in the 1930's was accomplished largely by encouraging private automobile manufacturers to expand. Production rose steadily from 173,000 motor vehicles in 1934 to 352,000 in 1939. In that year about 25 per cent of the 250,000 passenger cars produced were exported.

At the height of production in the late 1930's no center dominated the output of motor vehicles. At the beginning of World War II, two general regions were important in the production of automobiles and parts. The most important area was located in western Germany, with centers at Frankfurt, Rüsselsheim, Gaggenau, Stuttgart, Ulm, Augsburg, Mannheim, and Sindelfingen. There were more than two dozen smaller centers producing parts and accessories. This area produced approximately two-thirds of all motor vehicles in Germany. Motor vehicle manufacture was closely allied to machinery production, and many of the plants specialized in custom-built automobiles.

The second region of importance was located in central Germany with centers at Berlin, Brunswick, Leipzig, Chemnitz, Zwickau, and Fallersleben. The orientation toward machinery producing centers is unmistakable. It is important to stress that the automobile industry was not oriented toward large mar-

kets. The historical factor of available mechanical labor was of greater importance. The new small car manufacturers located where the luxury automobiles were produced.

The automobile industry suffered greatly during World War II. Although production declined because of material shortages and bombing damage, the United States Strategic Bombing Survey of the industry in 1945 revealed no systematic plan for converting the industry to war production. The German government expected a short war and in the early stages of the conflict decided to keep the plants intact for a large postwar production. In the later stages of the war when a partial conversion did occur the industry continued to produce vehicles as well as aircraft engines, tanks, and military equipment. Germany entered the war with about two million motor vehicles, but at the conclusion of hostilities there were only about 400,000 remaining in operation.

Modern trends. The German automobile industry began its recovery in 1948. Because of increased domestic and foreign demands, the rise of production has been spectacular. By 1955 the German automobile industry produced 22 times as many motor vehicles as in 1948, and double the number produced in 1938, the largest pre-World War II year. Five companies—Volkswagen, Mercedes, Opel, Borgward, and Ford—have experienced the greatest increases. Of the five companies Volkswagen has emerged as the major producer.

The expansion of the industry over the past decade has been a major factor in the industrial recovery of West Germany. The number of registered vehicles in Germany has increased from about 700,000 in 1948 to over four million in 1960. However, the export market has been of importance in the industry's rapid expansion. West Germany normally exports between 40 to 50 per cent of total production. Of a total production of 1,718,000 vehicles in 1959, 870,817 were exported. Since 1955 Germany has been the leading exporter of vehicles to the United States. German automobiles have gained acceptance in other countries. For example, in Sweden the preference for German cars rose from about one-quarter of imports in 1954 to about half of the imports since 1955.

UNITED KINGDOM

The manufacture of motor vehicles in Great Britain is now one of the country's key industries. It grew from little relative importance in 1920 to third place in factory output in 1935, a position it has held to the present. In 1960, in respect to insured workers, the industry was exceeded only by general engineering among manufacturing industries and in nonmanufacturing industries only by building and civil engineering, coal mining, agriculture, and the distributional trades (36). In a number of postwar years motor vehicles have occupied first place in export trade. This greatly contrasts with their prewar export position, when textiles, coal, iron and steel, and chemicals greatly exceeded vehicles. At present the motor vehicle and allied industries employ about 1,400,000 persons, of which 550,000 are engaged in vehicle transport and 270,000 in the operation of public service vehicles. Employment in the industry has increased by more than 50 per cent between 1939 and 1960.

Although Britain is the third largest producer in the world, the industry does not compare in size to that of the United States. Most of the "independent" American companies produce more vehicles than all British manufacturers combined, while General Motors produces four to five times the British output.

Early localization. The West Midlands is the traditional center of automobile manufacture. This region was ideally suited for the early growth of the industry. The bicycle industry started here in the 1870's and during the expansion of the next two decades Birmingham and Wolverhampton became major production centers. The highly seasonal character of bicycle demand together with the severe depression in the industry in the late 1890's provided an inducement for these firms to broaden their base of production. On repeal of the Red Flag Regulation, which required a man carrying a red flag to walk ahead of the automobile, the first automobile company was established in 1896. For many years several concerns combined the manufacture of motor vehicles, motorcycles, and bicycles.

Although the motor vehicle industry local-

ized in the West Midlands partly as a result of historical factors, the industry remained because of the diversified nature of the area's industrial economy. All basic raw materials in the manufacture of an automobile were produced in the region. There were many manufacturers who prospered by adapting their output to the manufacture of motor parts. The area also had a skilled labor force trained in the engineering trades.

The British industry during its first 25 years remained quite small in size. This early industry was characterized by the production of luxury cars, which limited car owning to a well-to-do minority. During this early stage of development the British market showed a preference for the high-powered American car. Consequently, British firms were handicapped in their growth as a result of American low-cost mass-production methods. By the time of the First World War, production in Britain was only about 40,000 vehicles annually.

Development of modern geographical pattern. The development of the modern automobile industry in Great Britain dates from the World War I period (10). Beginning in 1918 the British government encouraged the development of the domestic industry. In that year the McKenna Tariff imposed a 33.3 per cent duty on all imported vehicles, and in 1920 an annual tax of one pound per horsepower was imposed on all makes of cars. This permitted the British to develop a new market for small cars in which Americans were unable to compete.

In order to increase production the flow method of assembling automobiles was first used in the Morris works at Coventry in 1924. This method, adopted by English manufacturers about 15 years after it had been applied in America, is now in general use among the makers of the lower-priced cars. As the low income market for cars expanded, attention was directed toward production of light cars of eight to 12 horsepower.[1] To encourage this trend a heavy gasoline tax was imposed in 1928. The maker of the small car also received additional help by the imposition of compulsory third party insurance for motorcycles by the Road Traffic Act of 1930. This resulted in a decrease in motorcycle demand.

Combine these factors with a relatively level to rolling topography and short distances, and the success of the small car was assured. In 1927 half of all sales of new cars were 12 horsepower or less, but by 1938 the proportion of 12 horsepower cars had risen to more than 75 per cent. By United States standards the British eight to 12 horsepower cars are extremely small. Comparing them with standard American cars the wheel base is about 30 per cent less, width 20 to 25 per cent less, and weight about 20 per cent less.

As a result of developing a low priced car suitable for the domestic market and protecting it from foreign competition, the British automobile industry grew steadily after 1920. Production increased from 73,000 in 1921 to 280,500 in 1933, and reached a pre-World War II peak of 508,000 in 1937. Automobile production ceased during the entire war period, but was resumed in 1946 when 365,000 vehicles were produced. Production has been maintained at a high level and in recent years has been between 1,200,000 and 1,500,000 vehicles. About one-third of the motor vehicles produced are trucks.

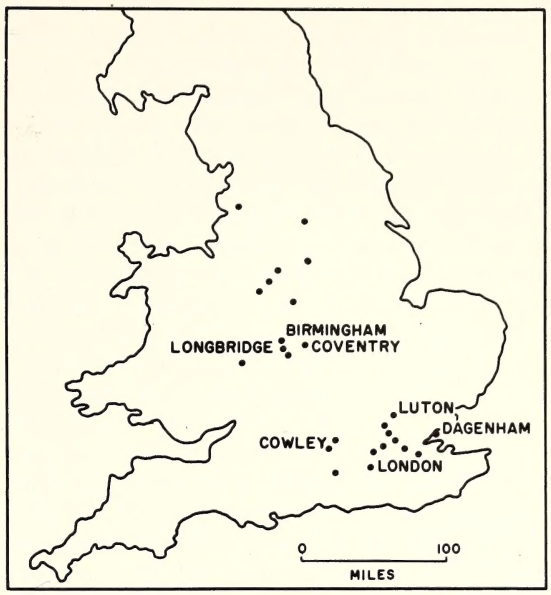
Because the number of vehicles entering the domestic market has been limited by strong governmental controls, the reason for this expansion can be found in the desire of the British to increase their export market. In addition, this policy has been encouraged by such factors as the high level of world incomes, the relatively slow recovery of the German industry in the earlier postwar years, the dollar shortage in many countries of the world, and the high demand for automobiles in the United States, which in the immediate postwar period kept the American industry occupied in supplying its home market. The British car has found a market in many countries, including the United States. During the 1950's the British surpassed the United States as the world's leading exporter of motor vehicles. The annual export varies from 300,000 to 400,000 vehicles, representing 30 to 40 per cent of total production. Of the

[1] In the United States the horsepower of a car is determined by brake horsepower which is three to five times the rating of British horsepower as applied by the British Automobile Club. The American Ford and Chevrolet are said to have 30 horsepower as determined by the British.

exports, more than one-half go to Australia, Canada, and the Union of South Africa.

The growth in production of motor vehicles has influenced the locational patterns of the industry. Although the West Midland centers, the hub of the industry from its earliest period, have expanded their production, this area has had a relative decline in output as a number of new centers have developed. The West Midland area remains the largest producer in Great Britain with about one-half of the total labor force. Birmingham with its suburb of Longbridge is the largest center of motor vehicle production. Although this city has five companies, the British Motor Corporation dominates production, with about 25 per cent of the national total. Birmingham is also a major center for the production of motor vehicle frames and bodies which are used throughout Great Britain. Coventry has remained a center of expensive car production, and thus is a leader in establishing style trends. Here are ten automobile factories, many of them associated with aircraft production. Other factories are concerned with the production of accessories. Because of this specialization in vehicles and parts, Coventry is sometimes known as the "English Detroit."

As small car production expanded, new centers developed in southeast England (Map 10.5). The market influence of this region. particularly London, appears to be the greatest factor in the establishment of these new centers (3). Oxford (Cowley), Luton, and Dagenham have had the greatest growth. The Morris works of the British Motor Corporation located at Oxford is fundamentally an assembly center, producing vehicles from parts made in the West Midlands. This center produces about 20 per cent of Great Britain's automobiles. The particular location of the industry at Oxford seems to have been fortuitous. It appears to have no special advantages that are not also found in many towns of the area. It does have a good centralized position in south England, and thus is well placed in regard to raw materials, labor, and markets. When the plant was established, there was an available supply of semiskilled workers who were easily trained for assembly line production. Skilled key personnel were imported from West Midland factories.



10.5. United Kingdom—Motor Vehicle Centers.

Vauxhall (General Motors) and Rootes have established factories in Luton. This center, which produces about 10 per cent of the automobiles and more than one-third of the commercial vehicles of the country, represents a median position between the raw materials of the West Midlands and the London market. The Ford Motor Company was originally located at Manchester, but production was transferred to Dagenham in 1933 in order to obtain advantages of proximity to the London market, large labor supply, and a better situation on the coast for the export-import trade. Ford has created in miniature the equivalent of its River Rouge plant at Detroit. It is one of the best examples of an integrated automobile factory in England.

In Britain the manufacturers of motor vehicles form three clearly defined groups—the so-called Big Five, the heavy vehicle builders, and the specialty car producers. The Big Five are the British Motor Corporation (formed by the merger of Austin and Nuffield in 1952), Ford, Vauxhall, Rootes, and Standard. These five firms dominate production, with about 90 per cent of the total number of cars and tractors and 80 per cent of the commercial vehicles. They concentrate on

mass-produced vehicles. The heavy vehicles, which total about 10 per cent of production, are produced by about 20 firms, of which Leyland Motors and Associated Commercial Vehicles are the largest. There are about 20 specialty car producers. The best-known specialty firms are Rolls-Royce, Daimler, Armstrong Siddeley, Jaguar Cars, and the Rover Company. The largest of these firms has an output far below any member of the Big Five. Many of the companies produce other engineering products besides vehicles.

A number of the British firms are American-owned or have connections with American companies. Among the vehicle companies, Ford and Vauxhall are outstanding examples of American ownership. The American Ford Company owns over 90 per cent of the ordinary capital of the British Ford Company, and General Motors owns all the ordinary capital of Vauxhall. Among parts and component manufacturers, two of the main producers of spark plugs—Champion and A.C.Delco—are subsidiaries of American companies. In the bodybuilding sector of the industry, Briggs is owned by the Ford Company. These are only a few examples of a common economic tie in the motor vehicle industry between the United States and Britain.

The British motor vehicle industry is not as highly integrated as the largest American companies. Parts and components are supplied by a large number of firms. However, as the industry has grown in size a considerable degree of integration has occurred, especially the merger of the vehicle with bodybuilding companies. The most highly integrated firms are Ford and the British Motor Corporation.

The motor vehicle industry is playing an increasing role in the economy of Britain. It is by far the largest consumer of sheet steel, taking about 20 per cent of all deliveries, and when producing at capacity the industry has to rely on imports as well as domestic production. The motor industry is the largest single user of machine tools in the country, making its own as well as buying from the machine tool industry. In many years the demands of the motor industry for machine tools dominate the market. The consumption by the motor vehicle industry of many other industries' products is so great that fluctuations in its output have significant effects on the stability of the economy as a whole.

SOVIET UNION

The automobile industry of the Soviet Union has developed entirely under communism. Although the first automobile factory was built in 1916, the first vehicle was not constructed until 1924.

Early developments. The impetus to develop the Soviet motor vehicle industry came with the inauguration of the first five-year plan. Between 1928 and 1932 the basic geographic pattern of the Soviet vehicle industry emerged. The industry was centered in Gorkiy and Moscow. Because the Russian engineering profession was poorly developed, the aid of foreign companies, largely American, was sought to develop the initial plants. The largest single factory—GAZ at Gorkiy—was built under contract by the W. J. Austin Company with technical assistance from the Ford Motor Company. This factory was completed in June 1932 and in 1937 produced 140,000 vehicles. The second largest factory was built at Moscow by the American Autocar Company and was completed in 1931. Brown-Lipe Gear Company, Electric Auto-Lite Company, Timken-Detroit Axle Company, Sieberling Rubber Company, and other American firms were instrumental in developing parts and accessory production. Between 1928 and 1932 at least 30 plants of this type were constructed or enlarged in Moscow, Gorkiy, Leningrad, Yaroslavl, Saratov, and Ufa. Small motor vehicle assembly plants were also constructed at Rostov and Omsk.

Production of motor vehicles in the U.S.S.R. rose gradually throughout the 1930's. Output was small under the first five-year plan. Although it was planned to produce 125,000 vehicles by 1932, output was only 33,000, of which 10,000 were assembled from imported foreign parts. The second five-year plan accomplished its goal with a production of about 200,000 vehicles in 1937, but failed in the production of spare parts and accessories, particularly tires. By 1937 the Russians had developed their motor vehicle industry sufficiently that outside technical aid was no longer required and foreign companies were re-

quested to leave the country. The third five-year plan proposed a production goal of 400,000 vehicles by 1942, but the Second World War curtailed expansion and it is estimated only about 100,000 trucks were produced in that year.

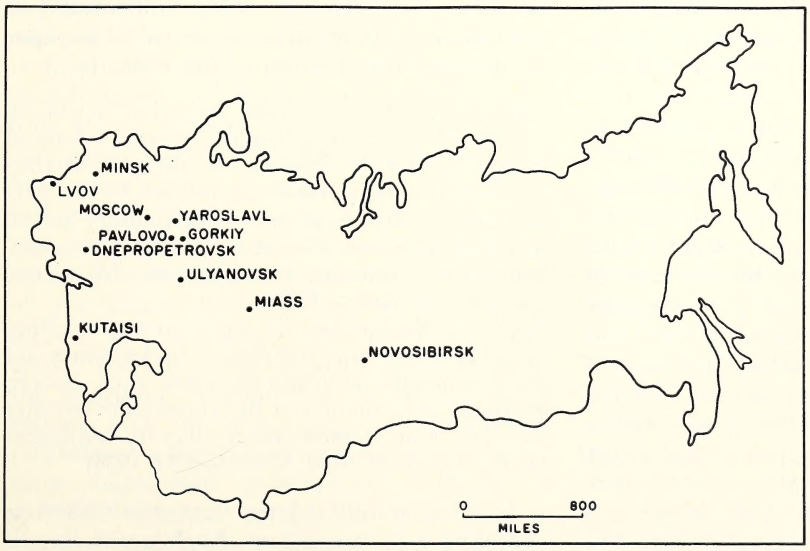
World War II was influential in a partial dispersion of the automobile industry. New plants were constructed at Ulyanovsk and Miass near the Chelyabinsk metallurgical center when it appeared that the Moscow-Gorkiy area would be captured by the Germans. Also in keeping with the trend to develop industry in the interior of Russia a diesel truck factory was established at Novosibirsk late in the war. War damage to the Soviet motor industry was relatively light consisting of the loss of the Rostov assembly plant and the severe bombing of the Leningrad plant.

Modern localization. The Soviet motor vehicle industry has remained concentrated in the Central Industrial Region of European Russia (Map 10.6). The Gorkiy and Moscow areas, which accounted for virtually all the U.S.S.R.'s prewar vehicle output, still produce nearly 80 per cent of the total. Two large establishments, the Gorkiy Automobile Plant (GAZ) and the Moscow Automobile Plant (ZIL) manufacture about two-thirds of Soviet vehicles. Twelve other vehicle plants produce approximately one-third of the total. Nine of these plants are of World War II or postwar origin. Operationally, eight are allied to one or the other of the Big Two. The four remaining plants produce their own vehicles.

The Gorkiy Automobile Plant is the largest automobile factory in the U.S.S.R. It may be the largest manufacturing establishment in the nation. Its output is about half the Soviet total for the industry. About one-third of GAZ's output consists of nonautomotive production. This includes bicycles, machine tools, radios, small electrical devices, and thousands of oil cans every month. Associated with this company are the Ulyanovsk and Odessa plants and the Pavlovo Bus Plant.

The Moscow ZIL plant is a relatively new name in the industry. The plant was originally named ZIS (factory named for Stalin), but in 1956 was renamed to honor its long time director, the late Ivan A. Likhachev. Besides motor vehicles it produces a variety of products such as electric refrigerators and large presses.

The ZIL organization has five allied plants. The Mytishchi Machine Building Plant is located on the outskirts of Moscow and produces trailers, tractors, bodies and hydraulic lifts. The Kutaisi Automobile Plant (KAZ) built since World War II and located in the Trans-Caucasian Georgian Republic, produces trucks. It has been noted for its economic difficulties. It often fails to meet production goals, labor productivity is low, manufacturing



10.6. Soviet Union—Motor Vehicle Centers.

costs are high, absenteeism is a problem, and its directors have been accused of bureaucratic mismanagement. The Dnepropetrovsk Automobile Plant (DAZ), also of postwar origin, produces most of the trucks used in the Ukraine. The Lvov Autobus Plant (LAZ) produces autocranes mounted on trucks and city busses. Finally, Miass (Yrad ZIS) has developed as an important truck producing center.

The smaller independent producers are located in four centers. The Yaroslavl Automobile Plant (YaAZ) specializes in diesel engines and large trucks. The Minsk Automobile Plant (MAZ) is one of the major automobile plants built in the U.S.S.R. since World War II. MAZ is one of the new establishments in Belorussia and the largest producer of heavy-duty diesel trucks in the U.S.S.R. The Moscow Small-Car Plant (MZMA) produces the 35 horsepower Moskvich 402 passenger car. This is the most popular privately owned car in Russia. The Novosibirsk plant is a small producer of trucks for the central Siberian region.

Types and characteristics of vehicles produced. The Soviet motor vehicle industry produces a narrow range of basic vehicles (18). Emphasis has been placed on truck production. The most common types are dump, cross-country, and tractor models. The limitation of variety of trucks necessarily leads to problems in their satisfactory use. Although some specialized adaptation has been established, the most common solution is for the state-operated motor pools to remodel vehicles themselves.

There have been a minimum number of model changes in trucks in recent years. Model changes are infrequent because of the difficulty and cost of retooling and the unavoidable disruption of production which accompanies it. Because of technological obsolescence the Soviet trucks are characterized by outmoded design, excessive weight, generally high fuel consumption, and uneconomical operation.

Passenger car production in the U.S.S.R. consists almost entirely of three basic models. Two cars of 35 and 66 horsepower and a jeep comprise most of the production. A few higher-priced cars are produced. The Soviet cars have been modernized in recent years. The bodies have been enlarged, the glass area increased, and a heater and seats which convert to beds have been installed. Engines have also been improved by increasing horsepower, piston displacement, compression ratios and other changes. However, most cars still have only four cylinders. This is traceable to the limitation of compression ratios imposed by the poor quality of Soviet gasolines. The average octane rating of commercial gasoline in the U.S.S.R. in 1960 was 65 to 70.

Soviet automobiles are becoming more like those produced in Western Europe. There appears to be no trend to emulate American cars in size and power. The present Soviet trend to somewhat larger cars is only partially satisfactory. The price of even the smallest car requires years of saving before the average Soviet worker can pay for one. The Moskvich sells for about 15,000 rubles, approximately a year and a half's wages for the average worker in the Soviet automobile industry.

Production characteristics. The development of the motor vehicle industry has been regarded by the Soviets as one of the greatest achievements in their socio-economic system. In scale, organization, and production technology, this industry has been said to exemplify the most advanced branch of Soviet industry. This assertion was true for a number of years when the plants were new and modeled after the best plants in the Western World. It now appears that many of the plants are old and outmoded. The following two quotations from a Soviet technical newspaper summarizes the position of the industry.

> Until comparatively recently, the technology of automobile production was among the most advanced in Soviet machine building. At the present time however, it is quite backward relative to the level achieved by other branches of our industry and to that of contemporary world technology. (Proniyshlenno-ekonomicheskaya gazeta [Industrial-Economic Gazette], February 3, 1957)
>
> Against a background of rapid growth of other branches of machine building, a backwardness (of the automobile industry) becomes ever clearer, gradually the situation of the automobile industry has come to be characterized by the very unpleasant word, stagnation. (Ibid, November 14, 1956)

The automobile plants were established as complete-cycle operations. Each plant has its

own forging and casting shops, machine shops, and assembly lines as well as machine tool and repair shops. In addition, most of the parts are produced by each company for its motor vehicles. This unspecialized industrial structure was necessitated by the lack of development of standardization or interchangeability of products and parts. Standardization throughout the motor vehicle industry has been retarded because the small scale of production has been insufficient to justify the investment of additional precision tools. The installation of less precise machinery contributed to the development of highly self-contained establishments and discouraged standardization on a national scale (22).

The basic means of direction has been a multiplicity of goals set by the government for each plant. These goals have covered virtually every aspect of plant operation. On the basis of the plant-wide goals, targets are set for each shop. The plant's progress is checked through monthly reports submitted to the government. Formulas provide for specific financial rewards to those responsible for the fulfillment or over-fulfillment of their goals. Certain of the goals are more important than others, and this is reflected in the reward system. Generally, the most important target has been raising the gross value of output.

As this system developed it evolved characteristics and tendencies which directly affected operations. Because of complexity, dependence on increasing masses of statistics, and inability to anticipate innovations, centralized planning for a large number of establishments has become largely mechanical. The heavy reliance upon statistical reports for control and for the distribution of rewards has caused a basic orientation toward quantity rather than quality. The need to meet an output goal has resulted in concentration upon its fulfillment at the expense of cost of production and the type of product required by consumers. The frequency with which the operating reports are submitted, the continual modification of the incentive system, and the slow speed of rewards or punishments has created a tendency to maximize immediate production. Because of excessive internal competition and lack of standardization, plant directors avoid dependence upon other establishments for parts or supplies wherever possible.

The overall effect of these factors has been to create an atmosphere in which everyone, from the plant director to the ordinary machinist, is motivated only toward the fulfillment of his own periodic production goal in the units or terms used on the reporting form. As a result quality of production is frequently ignored. This narrow, mechanical approach is known in Soviet jargon as "formalism." Its operation within the motor vehicle industry has created many problems for the present period.

FRANCE

France was among the first countries to develop the motor vehicle industry. As early as 1899 there were 47 manufacturers—who sold their cars through no less than 1,150 sales agents—and there were 6,546 motor vehicles on French roads. Until the 1920's, however, production of automobiles in France was a handicraft industry, producing only luxury cars. The industry was widely scattered with Paris and Lyons being small centers of concentration.

Development of the modern industry. The development of the small, inexpensive car was begun by Andre Citroen in 1919 when the first automobile assembly line was constructed in Paris. At this time there were 150 car manufacturers in the country. During the 1920's the motor vehicle industry grew rapidly. In 1929 when France produced 253,000 motor vehicles, Citroen had a production of about 140,000 units.

The economic depression of the early 1930's adversely affected the industry. Motor vehicle production declined to 183,500 at the depth of the depression in 1932. For the remainder of the 1930's production rose slowly to 228,500 units in 1938, but was not able to recover the level of 1929. Many companies failed during this period and those which remained adopted American techniques of production. This was a period of standardization and simplification. As a result four companies—Renault, Citroen, Peugeot, and Simca—emerged as the major producers. The motor vehicle industry employed about 175,000 workers, of which

100,000 were in the industry proper, 35,000 in auxiliary production, 9,000 in bodybuilding, and 20,000 in the production of tubes and tires.

Motor vehicle production ceased during World War II. At the conclusion of hostilities, the equipment of the automobile factories was not only old but had deteriorated from military production. For example, of the 85,000 machine tools employed in motor vehicle construction in 1938, nearly 16,000 were worthless, 42,000 were antiquated, and only 27,000 were usable. The average age of the machine tools was 20 years.

The re-equipping and modernization of the motor vehicle industry proceeded rapidly after 1945. By 1948 output of vehicles had reached the 1938 level. During the 1950's production rose steadily, and in recent years has totaled more than 1,280,000 units, of which about 20 per cent are trucks. There are now about 300,000 workers in the motor vehicle and allied industries. This industry is one of the largest consumers of raw materials and semimanufactured products in France.

Geographical pattern of production. In contrast to the dispersal of the motor vehicle industry in most European countries, the industry in France centralized in the Paris region in the late 1920's. This area has at least two major advantages to attract and maintain the motor vehicle industry. This is one of the most highly industrialized regions in France, and there is not only a body of workers available but many plants are well equipped for the manufacture of automotive parts and accessories. The Paris area also possesses the largest market in France. The basic geographic pattern of the French motor vehicle industry is still maintained, but a certain note of decentralization is appearing in the building of assembly plants outside the Paris region. Renault has developed plants at Le Mans and Rouen. Citroen has installations at Rennes and Strasbourg, Peugeot at Sochaux (Doubs), and Berliet in the suburbs of Lyons. In addition to this trend, subcontractors and parts manufacturers are widely distributed in France. These trends reflect the expanding market for motor vehicles beyond the Paris region.

The number of motor vehicle companies in France continues to decline. In 1935 there were 38 companies, at present there are fewer than 20. The four largest firms of the 1930's continue to dominate production. Renault, with its major plant at Billancourt near Paris, employs about 50,000 workers and has emerged as the leading producer, with 30 to 35 per cent of French output. Citroen in Paris is the second largest, employing over 20,000 workers and producing about one-quarter of the French total. Peugeot is nearly as large, having 18,000 workers. Simca, with its plant at Nanterre northwest of Paris, employs over 6,000 workers. Although the Ford Motor Company is one of the smaller producers in France, it has one of the most modern plants in Europe at Asnières. Ford produces a small truck as well as assembling American cars. The few luxury-vehicle companies remaining in France are located primarily in the Paris region.

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CHAPTER ELEVEN

MERCHANT SHIPBUILDING INDUSTRY

Shipbuilding is one of the world's oldest industries. Although history records the use of vessels more than 6,000 years ago, the modern iron and steel craft, propelled by mineral fuels, is barely over a century old. The growth of great merchant fleets is also as recent, with the world's gross tonnage increasing from 28,957,000 in 1900 to 68,509,000 in 1939, on the eve of World War II. Although there was great destruction of the merchant fleet during World War II there was also an unprecedented building program, and in 1950 the world's merchant fleet stood at 82,570,000 gross tons. By 1960 the world's merchant fleet had risen to over 120 million gross tons.

World ship production has varied tremendously between times of peace and war. Since 1900 the annual peacetime output of ships has been between 1,500,000 and 8,500,000 gross tons. Prior to World War II the largest shipbuilding year was 1919, when 7,144,000 gross tons of merchant shipping were produced through war contracts completed after the close of World War I. The interwar years were largely a period of low productivity, with fewer vessels produced in the early 1930's than at any time since 1840. In contrast, the World War II period was one of spectacular production. The annual output in the peak years of 1943 and 1944 was about 20,000,000 gross tons. Although production declined for a brief period after 1945, it began to recover by 1950. In the 1950's production rose steadily from 3,643,000 gross tons in 1951 to over nine million tons in the early 1960's. This rising output was maintained to a considerable extent by the increase in production of tankers. Since 1950 between 40 to 60 per cent of all merchant vessels produced have been tankers.

The great fluctuation in production between peace and war periods has created problems in the shipbuilding industry. During periods of national crisis new shipyards must be built and old shipyards renovated. However, during peacetime many of the world's shipyards are idle. In the United States about 90 per cent of shipbuilding capacity has been inactive since 1946. The average life of an ocean-going

vessel is about 20 years. In order to replace the present world fleet for peacetime commerce as it becomes obsolete, only about two to four million gross tons of new vessels need be constructed each year. However, during periods of global war, when there is urgent need for transporting large armies and the equipment necessary to supply them, demand for ocean transportation is increased between 15 and 20 times that of normal demands of international trade.

LOCATIONAL FACTORS

The construction of a ship is the largest assembly task in manufacturing. There are more individual parts in a large ocean liner than in any mobile structure made by man. There is also no other operation in which are found individual pieces of such great or minute size. These parts may vary from a rivet weighing a few ounces to a steel casting or forging of several hundred tons. About two-thirds of a ship's cost is normally allocated to supplies, of which steel is by far the most important basic material. It has long been a recognized fact that the greatest shipbuilding centers are oriented to iron and steel sources. In some of the major shipbuilding countries a number of firms have insured their steel supplies by direct association with the steel industry.

Although steel is a basic material, the modern shipbuilding industry also depends upon a large group of supporting industries which are frequently not associated with the shipyards. With every improvement in construction the diversity of materials and other equipment becomes increasingly complex. In the United States in World War II more than 500 subsidiary industries, located in 32 states, produced parts used in Liberty vessels, and more than 20 different inland firms made the 2,500-horsepower upright reciprocating engine used on these craft. In Great Britain the industrial Midlands produce many articles used in ship construction. For instance, ships' cables and anchors have been supplied by South Staffordshire, and a naval brass foundry is located at Birmingham, where it is associated with other branches of the brass industry.

Of the supporting industries, marine engines are most important. Most shipbuilding nations have developed a marine engine industry. Great Britain is the largest builder of steam engines, with a major percentage of world production. Since 1920 diesel engines have become increasingly important, with centers of production in northwestern Europe, the Soviet Union, Japan, and the United States. Switzerland, because of her advanced status in engineering, has become a leader in marine engine construction, although she is an inland country with no shipbuilding industry. Switzerland was the first nation to develop the gas turbine and other advanced types. Her engines are considered so superior that they are now used in nearly one-third of the world's motorships.

Besides materials and supplies a large labor force of skilled mechanical workers is a necessity. In peacetime each ship is essentially custom built in order to perform a specific function. For a shipyard to have an order for six ships of the same type is unusual except during war periods when mass production is necessary. The construction of a ship is a matter of individual design and construction entailing extremely elaborate procedures. It is not uncommon to have more than 5,000 workers building a single ship. Because of the great fluctuations in demand for new ships one of the chief problems is to maintain an adequately trained labor force in the shipyards. It is thus increasingly evident that modern shipbuilding can occur only in industrially advanced nations.

SITE FACTORS

Since the modern ocean-going ship varies from 100 to over 1,000 feet in length and from 40 to more than 150 feet in width special consideration must be given to the site of the shipyard. In order to provide shipways, storage facilities, warehouses, and assembling equipment, the ideal site for a shipyard is a deep protected harbor with several hundred acres of undeveloped shore area located close to steel and manufacturing centers. In many of the large ports of the world, docks, quays, warehouses, and other buildings monopolize

the shoreline and there is little space available to develop shipyards. In contrast, many places of the world have natural undeveloped harbors but lack accessibility to basic steel and other materials. The problem of available space is particularly important in times of international stress, when new shipyards are needed.

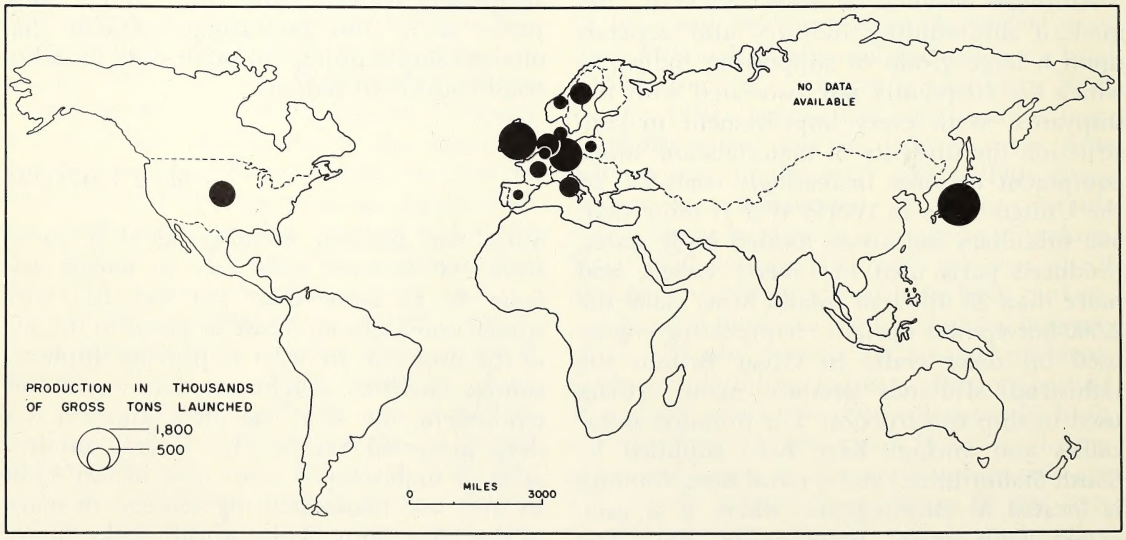
In recent years to conserve space at the shipbuilding site, many of the parts are assembled before being moved to the shipways. The delivery of single parts to subassembly stations, where separate groups of workers put them together, represents a marked advance in construction. The feasibility of this method, however, depends upon having adequate space at the head of the shipways for this intermediate process. Newly constructed yards try to make provisions for such space, but older yards may be located between the water's edge and a fixed urban area. Because the length of vessels has increased in recent decades, existing free space at the head of the ways in established yards may already have been reduced by having to extend the length of the ways to accommodate the larger ships. Because of the slope needed in launching vessels it is seldom possible to extend the shipways toward the water. When subassembly units can be established at the head of the shipways about one-quarter more space is available for the construction of additional shipways. This is particularly important during periods of high demand.

WORLD PATTERN OF PRODUCTION

Although most countries of the world have developed a merchant fleet, the shipbuilding industry is concentrated in a small number of industrially advanced nations (Map 11.1). The industry is primarily located in countries of northwestern Europe, the United States, and Japan. Of the European countries, United Kingdom, Germany, Italy, the Netherlands, France, and Sweden are most important (6).

Great Britain has been among the leading three largest producers of vessels during peacetime since about 1870. Her production has varied from as little as 15 to as much as 90 per cent of the annual world ship output. During periods of war the United States gains unquestionable supremacy, but has been a rather small producer of vessels during peacetime. Since World War II the United States has stood in sixth or seventh position as a shipbuilding nation. Production in the United States has varied from as little as 144 gross tons in 1934 to over 20 million tons in 1943. In the early 1960's the United States produced 500,000 to 700,000 gross tons of merchant vessels annually.

Prior to World War II Germany and Japan



11.1. World—Merchant Vessel Production—1960.

had developed a significant shipbuilding industry and were competing strongly with the British. These two nations were usually the second and third largest producers. Although production of merchant vessels was controlled in these countries in the early post-World War II years, it has experienced a remarkable growth since 1950. In 1956 Japan became the world's leading shipbuilding nation. In recent years Japan has built over two million gross tons of merchant vessels, surpassing the United Kingdom, the second major producer, by more than 600,000 gross tons. West Germany's recovery was also significant in the 1950's, and in 1959 an output of 1,252,000 gross tons placed this nation third in the world. Of the smaller producers in Europe, Sweden annually produces about 800,000 gross tons, Italy 520,000, the Netherlands 600,000, France 450,000, and Norway 250,000 gross tons.

UNITED KINGDOM

Development of shipbuilding. Great Britain has been a maritime nation for more than 500 years. Consequently, her shipbuilding industry is very old. During the period of wooden vessels, however, the industry remained quite small. British supremacy was not clearly established until after 1850, coming with the change from wooden vessels to those of iron and later steel. Iron ships appeared in the British coastwise trade as early as 1800. By 1830 the iron steamer was being built in shipyards on the Thames, Mersey, Tyne, and Clyde rivers.

The emergence of Great Britain as the leading builder of steamships may be attributed to a number of reasons. Iron vessels found increasing acceptance in passenger service, the British navy, and the merchant marine. By the late 1850's iron steamships, costing from 10 to 15 per cent less than wooden ships, were more durable and faster. The great increase in total demand for shipping in response to the rapid growth of international trade aided the change-over from wood to iron. At the same time the diminishing supply of ship timber in Europe and North America helped to usher out the wooden vessel.

The world center of shipbuilding shifted from eastern North America to Great Britain between 1855 and 1875. Britain had the finest natural locational advantages for securing leadership in building iron vessels. This country possessed a diversified industrial economy and could produce the multitude of components and materials required. The British coal mining industry was the best developed in the world, and an adequate fuel supply for the vessels was thus readily available. Most important of all, the development of the steamship coincided with the period of British supremacy in iron and steel production.

After 1850 there were great technical advancements in ship construction. The Institute of Naval Architects—the first scientific society in this field—was founded in 1860 to provide a means of pooling and circulating technical knowledge about iron ships. By 1870 steel began to replace iron for ships and boiler plates. This change was of special importance for it reduced the weight of the hull and consequently increased the carrying capacity. The use of steel for boilers enabled greater pressures to be maintained, reducing fuel consumption and also increasing speed.

Technical advancements gave Britain an unparalleled advantage in building the steel steamer. Continental European countries and the United States, in spite of their rapid advancement in other industrial fields, were slow to develop a substantial shipbuilding industry, so great were the relative advantages of Great Britain. By the 1890's Great Britain had gained its greatest dominance, producing between 80 and 90 per cent of the world's merchant vessels.

Localization. During the long period of wooden shipbuilding the industry was widely dispersed, developing along river banks and in harbors that had access to suitable timber. A center of high-quality ships developed on the lower Thames River. This area possessed a number of attractions for the establishment of the early industry. Its right bank tributaries drained the Weald, one of the largest timber tracts in England. It was also well located for producing naval vessels, and from incomplete records it appears that in the 1840's more than one-third of the workers engaged in shipbuilding and repairing on the Thames

were employed in naval shipyards. There was also shipbuilding at ports where timber from Scandinavia and North America was imported. The Liverpool area of the Mersey River and the Sunderland area of the Wear River had shipbuilding yards based to a large degree on imported timber.

With the development of the iron and steel vessel in Great Britain, the lower Thames River area, as well as the many small producing centers, declined in importance. The lower Thames area was not well situated for supplying iron and steel to the shipbuilding industry. The industry was oriented toward large undeveloped natural harbors and a supply of nearby steel. The Tyne, Tees, and Wear river valleys of northeast England, the Clyde River valley of western Scotland, and the Belfast area of Ireland were ideally situated to meet these site requirements. In western Scotland the principal shipbuilding centers are Glasgow, Port Glasgow, and Greenock. On the Northeast Coast major yards are located at Sunderland, South Shields, Tynemouth, Gateshead, and Newcastle. In 1914 the Northeast Coast produced 56 per cent of the total British output while western Scotland had 33 per cent. Combined, these two centers had 89 per cent of the island's shipbuilding.

The Tyne and Clyde river areas remained the largest shipbuilding centers between World War I and II but two trends were evident. The first was the continued growth of the Scottish section along with the decline of the Northeast England area, and the second was a general rise of a number of minor shipbuilding centers. Beginning about 1930 a specialization developed in each of the regions. Tramp freighters and tankers constituted the main, though by no means the only, classes of merchant shipping built on the Northeast Coast. The Scottish yards emphasized the output of ocean liners partially because of the greater availability of space on the long, deep-water estuary of the Clyde. Since there was a greater demand for passenger vessels than for freighters the Northeast Coast declined both relatively and absolutely in relation to west Scotland production. In the 1934-38 period these two areas had 76 per cent of the British total. Of this amount 42 per cent was concentrated in west Scotland and 34 per cent on the Northeast Coast.

The economic depression of the early 1930's greatly affected production in the older areas. Because they were slow to recover a number of minor centers gradually increased their importance. Northwest England, with important centers at Birkenhead near Liverpool and Barrow-in-Furness produced 10 to 12 per cent of the ships built in Great Britain. Smaller centers, with each having 5 to 6 per cent of the total, were situated on the east Scottish coast at Dundee, Burntisland, Leith, and Aberdeen, and on the east English coast at London and Hull. This dispersal represented the greater diffusion of the engineering industries and the growing importance of the diesel-powered ocean-going vessel. It also represented the establishment of a uniform delivered price for steel plates and sections, regardless of the place of origin of the material in Great Britain.

The general locational pattern of shipbuilding has not been altered by World War II or postwar conditions. However, the importance of the different regions has undergone a significant change. In recent years the Northeast Coast has increased its share of the tonnage built. This area now produces about 40 per cent of the British vessels. In contrast the Clyde District has declined in relation to the pre-World War II position, producing about one-third of the total gross tonnage built. These two regions continue to produce about 75 per cent of British ships. The changing importance of the districts reflects the emphasis on tankers and freighters rather than passenger vessels since 1945. The Northeast Coast is traditionally a producer of these types of vessels. The Scottish Lowlands region, with its interwar emphasis on passenger vessels, has had greater difficulty in shifting its shipyards to the production of tankers.

The lesser shipbuilding centers, mainly the Mersey, Barrow, and Belfast areas, have maintained their position. Since 1945 there has been little incentive in the United Kingdom to establish new shipyards. Investment control and steel and labor shortages discourage the development of new centers. In the entire postwar period only one new shipyard has been established, at Newport. In general, the de-

mand for new ships is not sufficient to necessitate the development of new centers.

Decline and recovery. Although Britain still maintains a major place in shipbuilding during peacetime, her relative position in the world has gradually declined (11). In the late 1930's Great Britain was producing only 35 to 40 per cent of the world's merchant fleet. The British decline is attributable to a number of factors. The most serious problem affecting the industry was the technical change from coal to oil-powered vessels. Although Britain was ideally suited to produce and fuel the coal-powered vessels, the British Empire is notably lacking in oil resources. The British industry has adapted itself to the construction of steam vessels and patents, since the diesel engines and motorships were largely developed abroad. This trend is indicated by the fact that in the 1927-30 period Britain built 65 per cent of the world's tonnage of steamships, but only 41 per cent of the tonnage of the world's motorships. The change to oil-powered vessels was encouraged by its convenience, low cost and the tendency of commerce to require larger and speedier ships, for which the internal combustion engine is particularly suitable. Although the advancement in technology from wooden to iron vessels gave supremacy to Great Britain in shipbuilding in the nineteenth century, a further technical change from coal to oil resulted in the growth of new centers, with a resultant decline in British output.

Other factors contributed to the decline between the two World Wars. As a result of the building program during World War I there was considerable excess shipping capacity available so that demand for new ships was small for a number of years. Britain had specialized in the tramp steamer and demand was now growing for the combined cargo and passenger vessel. The newer yards of northwestern Europe were better qualified to produce this type of vessel in the interwar period. Britain had also lost a part of her export market in ships as a result of the change to motor ships. The high taxes on industrial output also made British vessels more expensive than those produced on the Continent. Finally, many countries were encouraging the development of a domestic shipbuilding industry by granting government aid and subsidies.

As a consequence of the decline in production, the British yards soon became antiquated. Poor working conditions, such as long hours, lack of labor saving machinery, inefficient and outmoded methods, and crowded home conditions made the shipbuilding industry unattractive to the British worker. In the period 1920-23 over 150,000 men left shipbuilding. From a peak output of 2,055,000 gross tons in 1920, production declined to a low of 133,000 gross tons in 1933. During the ten years 1929-39 the average annual output of merchant ships was 759,000 gross tons, or less than 30 per cent of the industry's capacity. Great Britain entered World War II with a shipbuilding industry that had been in economic difficulty for nearly two decades.

With the beginning of war in 1939 the shipbuilding industry was one of the first to be expanded. On February 1, 1940 the Admiralty took control of the shipbuilding program. This program reached its peak in 1942 when 1,270,000 gross tons of shipping were produced. It must be appreciated that the United Kingdom's industry was at no time one of volume such as that of the United States or even Canada. The assembly line method of producing large numbers of ships was not utilized in Britain to any degree. It was a program consisting largely of the building of special types of merchant vessels for war transport. It must also be remembered that naval construction utilized a considerable amount of available facilities. Of all problems, the shortage of labor was most pressing. At no time was the labor force equal to the plant and berth capacity, and this condition prevailed throughout the war, being more keenly felt on the Clyde than elsewhere. The long period of depression resulted in a poor quality of labor. Shortages of materials, particularly steel and timber, also limited output. Because of the tremendous demands for vessels and the inability to produce them at home, the British contracted for ships in foreign countries, particularly the United States, Canada, and Hong Kong.

One of the significant developments during the war was the modernization of the British shipyards. Emphasis was placed on the pro-

duction of oil-powered vessels. As a result of the war program the British shipyards were in an excellent position to rebuild the merchant fleets of the world at the conclusion of hostilities. The European shipyards were largely destroyed and the high cost of American ships made them prohibitive in foreign markets.

Great Britain in the early postwar period once again assumed its position as the world's leading shipbuilder. British shipyards replaced the tonnage lost in the war, reconditioned ships, and built vessels for foreign owners whose fleets had declined during the war years. In the late 1940's annual output averaged nearly 1,250,000 tons, of which about one-third were exported. During this period the United Kingdom had regained her dominant position in shipbuilding with nearly half of the world's output. As a result of the dynamic recovery of the industry the labor force rose from 145,000 in shipyards and 52,000 in marine engineering in 1939 to 220,000 in shipyards and over 80,000 in marine engineering in 1949. The number of workers had increased to approximately the 1914 level, thus reversing the trends of the two decades prior to 1939.

By 1950 the world's tonnage of vessels was considerably greater than before 1939. It thus appeared that the activity of British shipyards would be curtailed. Nevertheless, during the 1950's output remained stable, averaging over 1,400,000 tons annually. Several factors have been effective in maintaining the British shipbuilding industry. The outbreak of the Korean War led to an increased demand for dry cargo vessels in the early 1950's. More important, the demand for oil tankers has risen steadily since 1950. Between 1950 and 1960 world demand for oil rose about 8 per cent annually, and since the distance from the oil producing centers to refineries and markets increased, the demand for oil tankers rose by 10 to 11 per cent annually. Over 40 per cent of the tonnage launched in the British shipyards in the 1950's consisted of tankers (16).

Although the British shipbuilding industry was maintained at a high level, the world position of the United Kingdom has declined greatly. By 1960 the United Kingdom was producing only about 15 per cent of the world's tonnage. The decline in the relative position of the United Kingdom has been caused by an increase in the output of other countries, primarily in Japan, Germany, Sweden, and the Netherlands. The reasons for the lack of expansion of the British shipyards in the 1950's appear to be quite different from the factors that depressed the industry between 1919 and 1939. During this period Britain was not able to compete successfully with foreign producers largely because of the high cost of British ships. During the 1950's it was not foreign competition or a dearth of orders that limited expansion. Rather, there were such physical problems as maintaining an adequate labor force and difficulties in securing supplies of steel. Managerial problems such as reorganizing and re-equipping the shipyards in line with modern shipyard practice also limited expansion. Many shipbuilders, remembering the depressed conditions between the World Wars, were reluctant to expand, thus robbing the industry both of the will and the means to increase rapidly. This pessimism extended to recruiting new workers, since many men felt that shipbuilding offered little stability of working conditions. This idea was enhanced for several years in the 1950's when steel was in short supply. It became difficult to increase the number of workers as a result of periodic lay-offs even when these were of short duration. A considerable effort is being expended to reorganize production facilities so as to increase output per head and expand tonnage to about 1,750,000 gross tons annually. The future of the British shipbuilding industry will depend on increasing productivity not only to raise the level of production but to reduce costs and improve the competitive position (12).

UNITED STATES

Development pattern. Shipbuilding was one of the earliest industries developed in Colonial America. The industry started and expanded along the northeast coast, particularly in New England where about two-thirds of the industry was concentrated in 1850. The location of the industry was due primarily to the important advantage of having lumber for large oak frame timber, pine planking, and great masts available close to a coastal position. The "golden era" of this period of ship-

building occurred in the 1840's and 1850's when the United States was the world's greatest producer of wooden vessels. During the years of the great boom, 1847-1857, the United States produced 3,390,000 gross tons of shipping, compared to 1,757,000 gross tons in Great Britain, her nearest competitor. If all ships are included, the peak tonnage in the United States prior to World War I was reached in 1855 when the figure stood at 583,000 gross tons.

The supremacy of the United States can be accounted for by a number of factors. The northeast coast gained an advantage in supplying the vessels of the merchant fleet of the world as the large ship timber of northwestern Europe became depleted. There was about a 50-year lag between the exhaustion of timber resources in Europe and in the northeast coast of the United States. At the same time that the northeast coast developed a raw material advantage, it also gained a technical superiority in the art of designing and building large, fast sailing vessels many of which were used in the illegal slave trade. Finally, the California Gold Rush, with its resulting demands for ocean transportation facilities, provided a large and immediate domestic market for the shipbuilding industry.

By the 1860's shipbuilding was rapidly declining in the United States as a result of the growth of the iron vessel in Great Britain. The United States rapidly lost her technical superiority in building ships. The last half of the nineteenth century was also the period of great westward expansion in the United States, and the people of this country were occupied with internal developments. There was little interest in developing international trade when domestic commerce was expanding rapidly.

By the 1890's a small iron and steel shipbuilding industry was developing in this country. However, from 1860 to World War I the annual output was only between 5 and 10 per cent of the world's total. The availability of steel was the greatest factor in the establishment of the modern pattern of shipbuilding. The major centers of the industry shifted from New England to the Middle Atlantic Coast, with principal shipyards at Philadelphia, Chester, Baltimore, Norfolk, and Bayonne. In the New England area the shipyards, which are closely associated with the engineering trades, have continued at Boston, Providence, New Haven, and New Bedford.

Besides the development of steel shipbuilding centers on the Atlantic Coast, a number of shipyards were established on the lower Great Lakes. With the opening of the iron ore deposits in the Lake Superior area and the development of the western wheat lands, trade on the Great Lakes increased rapidly. Since the 1890's about one-third of all vessels produced in the United States in peacetime have been built at Great Lakes' ports such as Cleveland, Buffalo, Chicago, Toledo, and Ashtabula.

Shipbuilding during the World Wars. The United States in modern times has been a great shipbuilding nation only during the World War periods. The American shipbuilding facilities were greatly expanded during World War I and production soared from 504,000 gross tons in 1916 to 4,075,000 gross tons in 1919. Immediately following the war shipbuilding declined to a low ebb for the entire interwar interval. In 1936, the Annual Report of the National Council of American Shipbuilders stated: "With the exception of oil tankers there was not a single seagoing vessel of the passenger combination or general cargo carrying type under construction in the American shipyards in 1936 for either the domestic or foreign trade, and for the fifteenth consecutive year not a single seagoing ship of the general cargo type has been built in an American shipyard for foreign trade and only a very few during the same period for domestic seagoing trade."

The government attempted to revive the industry by the Merchant Marine Act of 1936. By this act the U.S. Maritime Commission was established and policies outlined to create a modern merchant marine. At this time there were only ten active shipyards and 46 shipways in the country capable of producing ocean-going vessels 400 feet in length and approximately half of these were devoted to naval construction. The implementation of this program developed slowly so that the first passenger vessel, the "America," was not completed until 1940. It is thus evident that the United States entered World War II as a minor shipbuilding nation.

The expansion program of shipbuilding during World War II was almost fantastic in its scope. The United States established a wider margin of naval superiority over its nearest rival than any other sea power in history. In 1939 there were 38 yards containing 120 ways of 300 feet or more, employing some 120,000 workers. At the height of the program in 1944 there were 84 yards and 614 ways where 1,700,000 wage earners were employed. The building of merchant vessels increased from a total of 55 in 1940 with a gross tonnage of about 640,000 to a peak of 1,896 vessels in 1943 with a gross tonnage of more than 19 million. The number of cargo vessels increased from 61 in 1941 with a gross tonnage of 423,000 to 1,175 vessels with a gross tonnage of 8,455,000 in 1944. In the same period the number of tankers rose from 28 vessels with a gross tonnage of 267,000 to 240 vessels with 2,486,000 gross tons. During the four war years (1942-1945) American shipyards produced 4,889 merchant ships of over 2,000 gross tons each. In 1944 more than 120 vessels of all types and sizes were completed every day of the year. During the war years the shipbuilding industry became the second largest industry in the United States, and during most of this period it was the largest consumer of steel.

Besides the merchant marine program, American shipyards were called upon to construct a tremendous fleet of combatant and auxiliary vessels for the Navy. Some of the ships were specially developed designs which had never been built before. A total of 110,965 Navy vessels were built during the war years, including 1,323 combatant and 109,642 auxiliary types, representing 8,300,000 gross tons.

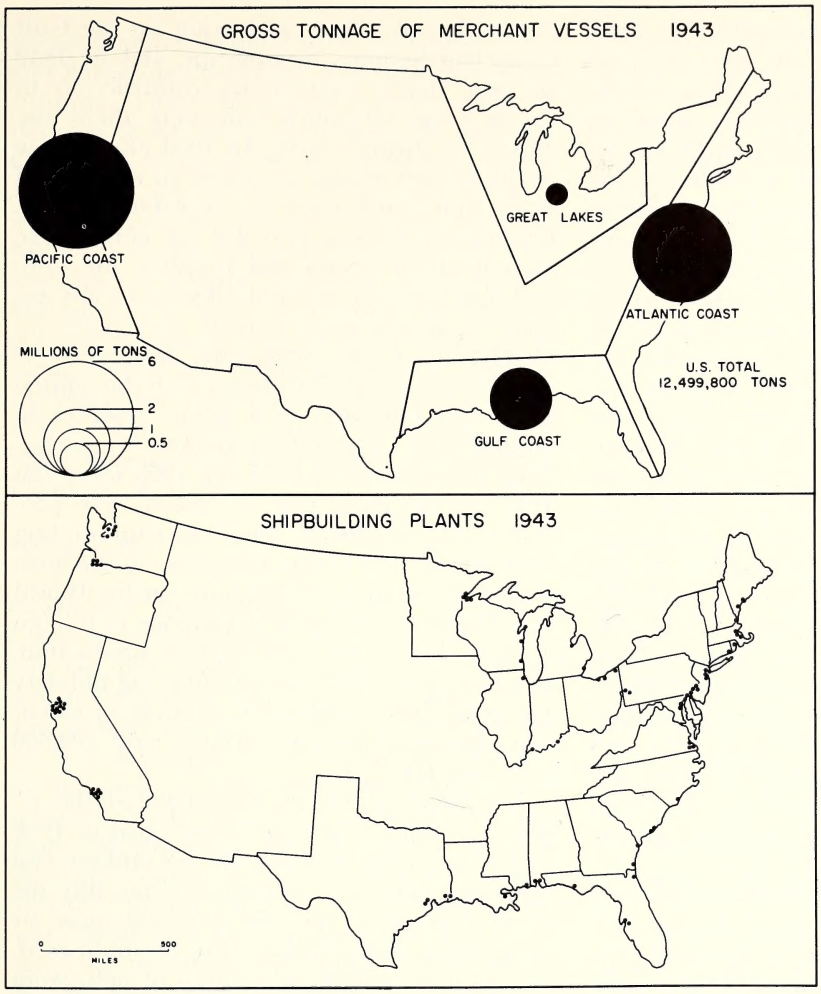
The war-born merchant fleet of World War II was about three times greater in number and four times greater in tonnage than that produced in World War I, when 1,903 steel merchant vessels of about 14 million gross tons were built in the 1917-1921 period. The World War II fleet was twice as large in number and almost three times greater in tonnage than the largest previous fleet, that of the British Empire, which before the war totaled 2,553 units of 22 million gross tons (including only vessels of over 2,000 gross tons each). In fact, this new American tonnage, because of an average 25 per cent increase in speed over prewar vessels, was practically the equal in carrying capacity to that of the world's entire prewar merchant fleet.

Location of shipbuilding during World War II. The demand for ocean-going vessels resulted in the greatest expansion of shipbuilding facilities the United States has ever experienced. Although the traditional Atlantic Coast centers were expanded, new centers were created. Shipbuilding centers also developed on the Gulf and West coasts. Many auxiliary vessels were built on inland waterways (Map 11.2).

Atlantic Coast. This traditional region of shipbuilding had 14 shipyards and 68 ways of 300 feet or longer in 1939. This was approximately 55 per cent of the country's shipbuilding capacity. In 1939, the important shipbuilding centers on the Atlantic Coast were Chester, Pennsylvania; Newport News, Virginia; Kearny, New Jersey; and Quincy, Massachusetts.

At the peak of production in World War II there were 24 shipyards on the Atlantic Coast with 233 shipways. However, as a result of the rise of new sites this represented only about 40 per cent of the country's total shipbuilding capacity. New centers of importance on this coast included Baltimore and Sparrows Point, Maryland; Savannah and Brunswick, Georgia; Wilmington, North Carolina; Wilmington, Delaware; and Jacksonville, Florida. The greatest expansion took place on the South Atlantic Coast. Steel was available from Sparrows Point and Birmingham, and there were also a number of good harbors, relatively undeveloped, in which large new shipyards could be built. Expansion of shipbuilding facilities in the New England area was quite moderate. The existing yards were used more as repairing and refitting points rather than having the construction facilities enlarged. During the war years the Atlantic Coast produced about one-third of all U.S. vessels.

Gulf Coast. The Gulf Coast has been an important producer of vessels only during war periods. In 1939 there were four shipyards and ten shipways of 300 feet or longer but no vessel had been produced since 1922. Expansion was significant and in 1944, the peak year of Gulf Coast production, the area had eleven active shipyards and 90 shipways of more than



11.2. United States—Merchant Vessels and Shipbuilding Yards—1943.

300 feet. This was about 18 per cent of U.S. capacity. The principal centers of shipbuilding were Mobile, Alabama; New Orleans, Louisiana; Beaumont and Houston, Texas; Panama City, Florida; and Pascagoula, Mississippi. During 1943 and 1944 the Gulf Coast area annually produced more than 1,700,000 gross tons.

Pacific Coast. The production of ocean-going craft on the Pacific Coast has also been limited almost completely to war periods. In World War I the output in this region rose from 12 per cent of the total in 1915 to 49 per cent of U.S. output in 1918. Production declined to less than 10 per cent in 1924 and after this date few vessels were produced in the region until 1940. The lack of local steel production on the Pacific Coast was the greatest handicap to peacetime output.

In 1939 the West Coast had eight shipyards and 18 ways of 300 feet or longer, but produced no vessels. In 1944 at the peak of production, 24 shipyards were in operation and 153 ways longer than 300 feet had been built. Production increased from 155,000 gross tons in 1940 to over 6,100,000 gross tons annually in 1943 and 1944. This was nearly one-half of all the ship tonnage produced in the United States. Major shipyards were located at Los Angeles, Wilmington, Richmond, Sausalito, and San Francisco, California; Portland, Oregon; and Vancouver and Tacoma, Washington. About 75 per cent of the capacity was concentrated in California.

Since the Pacific Coast shipyards had completed no vessels for nearly 20 years prior to 1940, shipbuilding here was in effect a new industry. Its great development was caused by the enormous scale of the warfare in the Pacific Theatre of operations. The growth of this industry created many problems for the region. Comparable to the airplane industry, shipbuilding brought huge increases in population and employment to the coastal states during the war. It was the most important factor in the development of a basic iron and steel industry in California. Steel ingot capacity was increased from an annual output of 1,070,000 tons in 1940 to 3,400,000 tons by 1943. Because of the shipbuilding demands some two score foundry and forging companies spent $25,000,000 for enlarging their plants. Altogether over 200 shipbuilding firms were active on the Pacific Coast and war contracts exceeded $7,000,000,000. In addition, contracts for materials and equipment were placed with more than 380 concerns outside the shipbuilding industry. Employment in the West Coast shipyards in 1944 exceeded 600,000 workers, and more than 100,000 were employed in auxiliary industries. By 1943 shipbuilding was recognized as the number one war industry on the West Coast.

Recent trends. At the conclusion of World War II the American merchant marine had 5,500 vessels of 57 million gross tons, and shipyards had a capacity to build ships at the annual rate of approximately 25 million gross tons. In 1946 the U.S. Maritime Commission estimated that the country could maintain an active merchant fleet of only about 11 million gross tons. To maintain this tonnage an annual construction of 500,000 to 600,000 gross tons is needed.

The immediate problems at the conclusion of hostilities were the curtailment of building new ships and the disposal of the war-built merchant fleet. All war contracts were cancelled, and even partially completed vessels were not finished. From a 1943 peak, when one out of every five tons of finished steel went to shipyards, the requirements for shipyards in 1946 were less than one-half of one per cent of the total steel output.

In the immediate postwar period most of the war-built shipyards were abandoned and dismantled. By 1947 production on the Gulf Coast had become insignificant, and by 1949 no new vessels were under construction in Pacific Coast shipyards, nor were there any orders for future vessels. In 1949 all but one of the 33 new vessels produced in the United States were constructed on the Atlantic Coast. Because the Korean War did not entail large movements of troops and supplies, the shipbuilding industry was not affected to any extent. If vessels were needed they were reactivated from the "moth ball" fleet.

In the decade 1947 through 1956 the United States was relegated to a minor position in shipbuilding. The lowest period of productivity was reached in 1955 and 1956 when less than 100,000 gross tons of vessels were produced. The decline of American shipbuilding after World War II was a response to the huge reserve of merchant vessels built during World War II and the inability to compete in foreign markets due to the high cost of production. However, since 1957 the shipbuilding industry has expanded considerably. Output in recent years has been between 500,000 and 700,000 gross tons (18).

A number of factors have favored the renewed activity. The Suez Canal crisis of 1956 created a world demand for oil tankers and American shipyards benefited from this demand. This trend has also been enhanced by the growing demands for oil in the industrialized nations, and the expansion of petroleum production in the nonindustrialized areas, such as the Middle East. In recent years between 85 and 90 per cent of the vessels built in the United States have been tankers.

Other factors are also important. The Maritime Administration of the federal government has developed a plan to subsidize the shipbuilding industry by replacing over 300 old ships with new vessels by the middle of the 1970's, most of which will be larger and faster. As a result of the operating-subsidy contracts in existence with the Maritime Administration, American shipyards are assured of an output in excess of 500,000 gross tons annually for more than a decade.

Because of the present program, a modern pattern of shipbuilding is evolving. The Atlantic Coast dominates production, with shipyards at Quincy, Massachusetts; Camden, New

Jersey; Chester, Pennsylvania; Sparrows Point and Baltimore, Maryland; and Newport News, Virginia. These six centers produce over 80 per cent of the American output. On the Gulf Coast one center exists at Pascagoula, Mississippi, and on the West Coast the industry is centered in the San Francisco Bay area. On the Great Lakes important shipbuilding centers exist at Toledo, Ohio and River Rouge, Michigan. In recent years there has been a gradual modernization of the existing shipyards. One of the trends has been to increase the size of the yards in order to produce larger vessels. The yards have also become more efficient to meet not only domestic but foreign competition as well.

GERMANY

Germany's shipbuilding industry has experienced wide fluctuations in production during the last half century. The modern industry, which dates from about 1900, expanded until the World War I period. This was the era of the development of Germany's overseas colonies and a rapid expansion of her international trade. Output of vessels increased from 153,000 gross tons in 1898 to 465,000 gross tons on the eve of the First World War in 1913. During World War I Germany's ports were blockaded and emphasis was placed on naval construction, particularly submarines. At the conclusion of hostilities the German naval and merchant fleet was essentially expropriated by the Allies, and in 1919 her total fleet was reduced to about 42,000 gross tons, compared with nearly 4,500,000 gross tons in 1913.

The shipyards remained intact, however, and immediately a shipbuilding program was launched. In 1921, Germany built 1,730,000 gross tons of shipping, almost 300 per cent greater than the peak years prior to World War I. Germany not only reconstructed her own fleet but became an exporter of vessels. During the 1920's Germany normally built about as many ships as the Netherlands, France, and Italy combined and was Great Britain's most important competitor. Emphasis was placed on the construction of modern diesel-powered vessels, which were largely responsible for the decline of Great Britain as a shipbuilding nation during this period. Germany's loss of her fleet after the First World War stimulated research and technical innovation in shipbuilding in order to give an advantage in competition with other countries.

This was a period of expansion and development of new shipyards in Germany. Hamburg was the leading shipbuilding center, as well as being a research center for experimentation with propulsion engines and turbines. Hamburg is well situated for a shipbuilding industry, being on the deepwater estuary of the Elbe River. Other shipbuilding centers in western Germany were Kiel, Bremerhaven, Wilhelmshaven, and Bremen. These centers are close to the steel producing areas of western Germany. In eastern Germany shipbuilding centers developed at Rostock, Stettin, and Elbing. The eastern German shipyards were not advantageously located to secure steel supplies and thus remained relatively small.

During the early 1930's shipbuilding declined drastically in Germany. Many shipyards were closed, and foreign orders became most important in keeping German shipyards active. For example, in 1930 72 per cent of the ships built were consigned to foreign countries. The shipbuilding industry revived with Hitler's economic program, output increasing from a low of 33,000 gross tons in 1932 to 435,000 gross tons in 1937. At the end of 1936, unfilled orders in German shipbuilding yards reached a record figure of 248 ships, totaling 978,000 gross tons. As the annual capacity of German shipyards did not exceed 650,000 gross tons, these orders were sufficient for about a year and a half of full production. This was in great contrast to the shipbuilding industry in Great Britain, where only a fraction of capacity was being utilized. Germany entered World War II with a shipbuilding industry that was modern and economically sound.

From 1939 to 1945 naval shipbuilding predominated in Germany, even more so than in Great Britain. It is estimated that during this period 1,100 submarines were constructed. The principal program of merchant shipbuilding was that of the Hansa-type vessels of 3,000, 5,000, and 9,000 gross tons. Of these, only 52 of the 3,000 ton ships were delivered. One large

36,000-ton passenger vessel, the Vaterland, was constructed during the war, but it was sunk before it left the dock.

At the conclusion of the war, the Potsdam Agreement stated: "In order to eliminate Germany's war potential, the production of arms, ammunition, and implements of war as well as all types of aircraft and seagoing ships shall be prohibited and prevented." As a result, German shipbuilding entered a period of stagnation. However, in 1949 the Allied High Command permitted West Germany to accept contracts for building ships for foreign countries, and the industry began its recovery. By 1951 most restrictions on shipbuilding in western Germany were lifted.

In order for the German shipbuilding industry to redevelop, the war-damaged shipyards had to be repaired. In other yards the equipment surrendered under reparation terms had to be replaced. To encourage recovery, subsidies and low-interest loans were granted the shipyards. Credits were provided by the Federal Republic, the coastal Länder, private banks, and the E.C.A., as well as by the use of counterpart funds.[1] By 1953 the shipbuilding companies were financing substantial operations from these funds. Special income tax provisions were also given to the shipbuilding companies. The government regulations have changed from time to time but the basic idea has prevailed that investors in the shipbuilding industry could claim their investments as costs to be set against income tax—up to a certain limit.

As a result of this active revival policy, shipbuilding production increased rapidly. In 1953 the largest prewar production year was surpassed, and output has continued to rise. Germany, like Japan, has concentrated on the production of cargo vessels and tankers. Much of the tonnage built has been for export. As production increased, problems of continually expanding output also have appeared. One of the most difficult of these has been the securing of an adequate labor force. There has also been the problem of an inadequate number of yards, necessitating two or three shifts of workers in order to speed the delivery date of vessels. In the postwar development of the industry most of the German firms do not have marine engineering plants associated with them. Only a few shipbuilding firms construct their own engines; most depend on specialist producers.

In the reactivation of the shipbuilding industry about 80 per cent is concentrated in eight shipyards: Deutsche Werft and Howaldtswerke in Hamburg, A/G Weser at Bremen and Bremerhaven, Kieler Howaldtswerke at Kiel, Lübecker Flender-Werke at Lübeck, Nordseewerke at Emden, and Bremer Vulcan at Bremen. The large shipyards are either state-owned or part of major combines. Only one moderate-sized shipyard in Hamburg is family controlled.

[1] A sum, in local currency, which each European country participating in the European Recovery Program is required to set aside to offset internally the gift of dollars made to that country by the Economic Cooperation Administration of the United States.

JAPAN

The modern shipbuilding industry began in Japan in 1895 with the first construction of a steel vessel. The industry grew rapidly in the next two decades, and during the First World War her output was exceeded only by that of the United States and Great Britain. Japan became an important exporter of vessels between 1918 and 1921, producing 30 vessels for the United States. From 1920 to 1939 Japan added to her commercial fleet at least 524 seagoing vessels, each over 2,000 gross tons, with a total tonnage of 2,973,000. During the same period, the United States added a total of 184 seagoing vessels of 1,586,000 gross tons (2).

The Japanese government has frequently encouraged shipbuilding by direct subsidies. The Ship Improvement Facilities Acts of 1932, 1935, and 1936 greatly enlarged production. By 1937 the 420,000 gross tons of ships launched were nearly eight times as great as in 1933; the total exceeded that of any other country except Great Britain. To encourage production, purchase of ships from foreign countries was practically prohibited. Other factors which stimulated Japanese shipbuilding were the low rate of exchange of Japanese currency and the rapid advancements in engineering techniques.

By the late 1930's the shipbuilding industry

had developed 85 shipyards, located principally in central and southern Japan. In the Tokyo Bay area Yokohama was the largest center; but Tokyo, Yokosuka and Uraga were also important. At the eastern end of the Inland Sea lies Osaka Bay, where the shipbuilding centers of Kobe and Osaka were found. The Osaka yards were among the largest in Japan, producing both naval and merchant vessels. In the Inland Sea area shipyards were located at Kure, Inno-Shima, Hibi, and Kasudo-Jima. Shipbuilding also developed at Kokura, Wakamatsu, Sasebo, and Nagasaki, all on the western coast of Kyushu. Minor shipbuilding yards were located at Hakodate, Nambajima, and Koyage. The shipbuilding industry was well located in respect to the steel producing centers of Yokohama-Kawasaki, Kobe-Osaka, Himeji, and Yawata-Kokura. The Mitsubishi Steel Corporation was among the largest builders of both merchant and naval ships in Japan. It is also important that southern Japan had deep, protected harbors so that excellent sites for shipyards were readily available.

Japan entered World War II with her shipbuilding industry in a good position to meet war demands. It is fair to assume that the shipbuilding capacity of Japan in 1939 was nearly as large as that of Great Britain, and had not experienced the economic problems which had plagued the British for nearly two decades. During the war the capacity of the shipyards was greatly expanded and, apart from large tonnages of naval vessels and wooden ships for coastal navigation, about 3,200,000 gross tons of steel merchant ships were built.

At the conclusion of hostilities, shipbuilding was rigidly controlled by the Supreme Commander of the Allied Powers. Because the policy of SCAP was to destroy Japanese war potential, it was recommended that the Japanese merchant fleet be limited to 1,500,000 tons of steel ships, and that no vessel should exceed 5,000 gross tons or have a maximum speed of over 15 knots. In addition, much of the shipbuilding equipment was to be seized for reparations and the remaining yards to be utilized largely for the output of coastal vessels and ship repair. However, industrial surveys in 1947 and 1948 concluded that the development of a sound economy in Japan depended upon a revitalized shipbuilding industry. In 1948 the first restrictions were lifted, and by 1950 SCAP's control of this industry was relinquished.

The great demand for ships created by the Korean War resulted in Japan's re-emergence as an important shipbuilding nation. Because of foreign demands Japan immediately became a significant exporter of ships. The initial financing for the new shipbuilding industry was provided by the government through the United States Aid Counterpart Fund. With the depletion of this fund the Japan Development Bank began providing funds at low interest rates. In 1953 a government-initiated policy permitted it to subsidize interest payments made by commercial banks to the shipbuilders above a minimum of 5 per cent. Thus, the government greatly aided the recovery of shipbuilding. These steps were considered necessary, since Japanese ships in the early 1950's were being produced at a higher cost than in Western countries. These high costs were to a large extent caused by the industry's low efficiency. The industry grew from the great demand and the brief delivery period offered. Japanese builders were also aided in meeting foreign competition by the use of the most modern techniques.

In order to overcome high-cost production the industry invested heavily in new equipment. Between 1950 and 1955 some 22,000 million yen were invested in new capacity. The number of berths for constructing new vessels was greatly increased, and the "block" building system and new welding techniques were utilized to reduce the time in building ships. By the mid-1950's Japan's shipbuilding industry was as well equipped as that of the most advanced European nation. Thus, Japan was able to take advantage of the rising demand for ships after 1955. In 1956 Japan assumed world leadership in the production and export of ships. In that year she had 26 per cent of the world's launchings, compared with 11 per cent in 1953. Japan had overcome her financial and technical handicaps and could compete on the world market so effectively that, by 1957, the government withdrew all subsidies and the Development Bank raised interest rates on loans to the shipbuilders.

Thus, within a few years Japan transformed her shipbuilding industry from a high-cost producer dependent on various types of subsidies and working at a low-level capacity to one of the most efficient and low-cost shipbuilding operations in the world.

The location of the shipbuilding industry has had little distributional change since World War II. The shipyards are concentrated in the southern portion of the nation where adequate harbors lie near the machinery and metal fabrication centers. The big ocean-going vessels are built by a few large firms, most of which make widespread use of subcontractors located adjacent to the shipyards. In addition to the large shipbuilders, there are many medium-sized companies producing small vessels from 500 to 4,000 gross tons for the southeast Asia countries and the Soviet Union. Besides these firms, there are hundreds of small shipyards producing wooden vessels for coastal trade and the fishing industry.

OTHER COUNTRIES

Along with the major countries there are a number of lesser but important shipbuilding nations. Many of these have specialized in the construction of a particular type of vessel. As a general trend, the minor shipbuilding countries have grown in importance in recent years (1).

The Netherlands. Among the several industries in which the Netherlands has specialized for many years is that of shipbuilding and ship repairing. The country has one large shipyard, six other shipyards producing between 25,000 to 50,000 gross tons of ships annually, and nearly 200 yards that produce a small number of ships each for a wide variety of uses. The small shipyards construct approximately one-third of the Netherlands output. Since 1900 the Netherlands has usually been the fourth, fifth, or sixth-largest shipbuilder. Annual production has varied considerably, from as little as 30,000 to over 600,000 gross tons. Since 1950 production has been maintained at a high level, with the shipyards employing approximately 44,000 workers (11).

The Dutch shipbuilding industry is highly decentralized. Amsterdam and Rotterdam are major centers, and many of the small shipyards are found along the country's canals. For example, there are 22 shipbuilding yards on the narrow Winschoter Diep between Groningen and Sappemeer. The canal shipyards reflect a high community spirit, and in depressed periods the local groups will combine resources to ensure that an order for a ship will not be lost. The Dutch shipyards have maintained a highly competitive position in spite of the fact that nearly all shipbuilding materials must be imported. Steel, the most important item, is largely obtained from Germany, Belgium, and Luxembourg. Although the Netherlands has few materials for this industry her coastal position, with an economy inevitably directed toward maritime activities, has encouraged shipbuilding. Thus, the Netherlands shipyards have always had an important domestic as well as foreign market for vessels.

In recent years the shipyards have concentrated on producing tankers, with some cargo vessels being built from time to time. There has also been some output of naval vessels. Passenger ships are of limited importance. Emphasis has thus been placed on quantity of ordinary ships rather than on luxury vessels. Besides the construction of vessels the repairing of ships is a major aspect of the industry. The repair docks are large and equipped with modern facilities.

The shortage of shipyard labor has been a problem in the Netherlands since 1955. Wages are closely regulated by the government and the trade union and employer's associations. The movement of workers between firms has been strongly discouraged. Increasing efforts have been made to train new workers. For example, boys may be given two or three years' instruction in schools attached to a shipyard. In order to make working in the shipyards attractive many amenities are offered. Excellent changing rooms, showers, and canteens are provided. The Dutch shipyards are seeking to make shipyard working conditions similar to the nation's advanced factory standards (11).

Sweden. Sweden became an important seafaring nation in the early part of the twentieth century. By the early 1900's Swedish shipping lines were reaching international

proportions, and the development of the present shipbuilding industry began. Sweden's production remained small until the 1920's when the annual output of ships showed an almost continuous rise; for a few years Sweden held third place in world shipbuilding. Production declined in the early 1930's and the Swedish shipbuilding industry was maintained through the export of specialty vessels. In the years 1930 to 1939 an average of 60 to 70 per cent of all tonnage launched by Sweden was exported, mostly to Norway, but also to Finland and other northwestern European countries. Just prior to World War II production increased sharply so that in 1939 Sweden produced 220,000 gross tons. During the war years merchant shipbuilding was continued but only between 100,000 and 150,000 gross tons were launched annually. Since 1945 Swedish yards have been expanded and are working at capacity. Since the early 1950's Sweden has been the world's fourth or fifth largest shipbuilder. Production has varied from 400,000 to 800,000 gross tons.

The three largest shipyards in Sweden are Gotaverken and Eriksberg at Göteborg and Kockums at Malmö. These three yards have each launched over 100,000 gross tons of ships in most recent years. In 1958 the Uddevallavarvet at Uddevalla also launched 100,000 gross tons, and Oresundsvarvet, a subsidiary of the Gotaverken yards launched 50,000 gross tons. It is generally recognized that the Swedish shipyards are the most efficient in the world. This efficiency is not due to the physical aspects of the shipyards, as the equipment is basically the same as in other countries. The distinctive feature appears to be managerial skill. There is evidence that productivity has been increasing steadily for many years. There is a high standard of organization shipyard management, and there are constant attempts to find more economical means of building ships. There is also the expectation that the cost of production will continue to decline. The dynamic aspects of management are also reflected in the selection of ships most suitable for the facilities of the yard, in the construction of a series of similar vessels with consequent savings in production costs, in a willingness to move the shipyards when the size of vessels outgrows a shipyard's berth, and the shrewd and careful purchasing of imported materials and components.

Within recent years Sweden has been developing industries to support her shipbuilding. Sweden originally secured much of her steel from Germany, but beginning with World War II several Swedish steel companies increased their production of ship plates. Diesel engines were formerly imported, principally from Denmark, but in recent years Swedish yards have constructed their own motors, the Gotaverken yards at Göteborg being outstanding in this type of construction. Sweden has always emphasized specialty and quality vessels. The majority of the ships are motor driven and high speed, and much attention has been given to improvement of loading and unloading facilities.

France. Since the early 1890's France has ranked between second and ninth in world shipbuilding. During most of the interwar years French shipbuilding was at a low ebb. Output was rarely over 100,000 gross tons annually. Considering the low productivity, France had a large number of shipyards. On the English Channel important centers developed at Rouen and Le Havre and small centers at Dunkerque, Cherbourg, and Caen. The western ports of St. Nazaire, Nantes, Lorient, and Brest are centers of shipbuilding. In the south centers are located at Marseilles, Toulon, La Ciotat, La Seyne-sur-Mer, Arles, Port-de-Bouc, and St. Tropez. The availability of a good harbor plus the ability to assemble the materials by water transportation are important factors in the location of the French shipbuilding industry.

During World War II France lost most of her merchant marine. In order to restore the war damages, the French shipyards have produced at a high level in the postwar period. Production has risen steadily from 138,000 gross tons in 1948 to 451,000 gross tons in 1958.

Denmark. Denmark is an illustration of a small maritime nation that has concentrated on the building of relatively small specialty vessels and the construction of diesel engines, many of which are exported. Since 1930 annual production has varied from 10,000 to over 250,000 gross tons. The largest shipbuilding yards are in Copenhagen, which produces be-

tween 75 and 80 per cent of the country's total. Other centers of shipbuilding are Nakskov, Odense, Helsingor, Frederikshavn, and Aalborg. The Danish shipyards have been producing at near capacity since 1945.

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CHAPTER TWELVE

AGRICULTURAL MACHINERY INDUSTRY

Farm mechanization has developed through three general stages, each depending on the motive power available. The tools of the first stage were designed for manpower, the second for draft-animals, and the third for mineral power. The advances in harvesting machinery during the past century illustrate these three stages of progress. The first means of harvesting was by the sickle and the knife. The invention of the cradle was an important advancement but still a primitive means of harvesting grain, being completely manual. With the development of the reaper, the binder, and the thresher, animal power began being utilized, thus revolutionizing the ancient methods of farming. The final stage, exemplified by the development of the self-propelled combine, has been made possible by the introduction of the tractor, with its use of mineral fuels for power. Tractors have not only reduced manual labor and made possible the elimination of draft animals—they have enabled farmers to perform many operations which were impossible with previous equipment and power.

Although the manufacture of farm implements is dependent upon agriculture, farming itself is still not dependent upon the manufacture of machinery. The use of farm machinery is not evenly distributed throughout the world. There are millions of farmers today who have no more equipment than a primitive hoe and sickle. The farm machinery industry is primarily dependent upon agriculture which has been revolutionized by agricultural machinery itself. Farm machinery has freed millions of people to pursue other economic activities in the industrially advanced nations. With the introduction of agricultural machinery to the less-advanced industrial nations, millions more will be freed from backbreaking manual labor in the decades to come (1).

DEVELOPMENT OF FARM MACHINERY

The agricultural revolution began in the United States at the close of the eighteenth century. A scientifically efficient moldboard

plow, developed by Thomas Jefferson, was one of the first improvements in farm machinery. During the first half of the nineteenth century patents were issued on dozens of new farm implements. By the 1840's the demand had grown so large that factories were being established to produce the agricultural machines.

The United States with its great areas of undeveloped land and sparse population created laborsaving devices in order to expand its farm economy (7). Many of the laborsaving implements were quite simple, such as the manure carrier and the rope for hoisting hay, while others, like the oscillating mower and the grain thresher, were far more complex. By the twentieth century most of the basic tools now known to farmers had been invented and built. Through these advancements, the elemental, hard labor of the ancient sickle, shovel, fork, and hoe was largely eliminated.

The great advance in the twentieth century has been the change from the draft animal to mechanized power. This has entailed the development of the tractor and the adaptation of horse-drawn machines to mechanical power. The tractor was transformed into an effective prime mover through the development of the economical, heavy-duty high-compression engine; the introduction of the tricycle front wheel, which made the tractor maneuverable and thus usable for row crop farming; and the simple substitution of rubber tires for the spiked or cleated steel wheel. Mounted on rubber, the tractor has more speed, flexibility, and ease of handling. Indeed, some believe the rubber-tired tractor to be the greatest agricultural improvement since the moldboard plow.

As the tractor developed, many agricultural machines have been designed or adapted for its particular use. These developments made possible the application of such tools as scoops, lifts, and bulldozers. Complete machines, like the three-ton cotton picker, are mounted directly on tractors. There are now hay choppers and sugar beet and potato diggers. One manufacturer is working on a machine for digging rocks from fields, crushing them, and spreading the pulverized rock back on the fields. Some machines now serve multiple functions. For example, the small, all-purpose combine can harvest more than a dozen different crops.

Although agricultural machinery has reached an advanced state of development, mechanization even of American farms is by no means complete. U. S. farmers still own three million horses and mules, and about 50 per cent of all farm work is done by hand. Some farms are highly efficient, such as the mechanized wheat farms; others, such as most marginal subsistence farms, are not. Even in the United States, which is the most highly mechanized farm country in the world, the geographic pattern of mechanization shows wide variations. Possibly the most astonishing fact about farming today is that the agricultural revolution is not complete, but is only entering its advanced stage.

EFFECTS OF FARM MECHANIZATION

One of the outstanding and significant effects resulting from the use of new and improved farm implements is the reduction in the quantity of labor required per unit of output. With respect to increased production per farm worker, it is estimated that while the surplus food produced by 19 farmers in 1787 went to feed one city person, in recent years 19 people on farms produced enough food for approximately 56 non-farm people in the United States plus ten abroad (7). Furthermore, the Department of Agriculture estimates that prior to the Civil War each agricultural worker cared for about 15 acres; in 1960, the average for the United States as a whole was more than 50 acres. This includes the intensive truck gardens and fruit farms, which require much more manual labor per acre than grain crops.

The farmer of today who does not use mechanical power is in a decidedly unfavorable competitive position. The number of acres one farm worker can care for without mechanical power is far below that cared for with the aid of mechanized farm equipment. In 1830 about 58 man hours were consumed to cultivate one acre of wheat for the production of 20 bushels. In 1960 cultivation of the same acreage to produce the same amount took only 3.2 hours. The reduction in labor

through the change from hand to machine amounted to over 90 per cent.

As a result of farm mechanization the physical limits of cultivation have been greatly extended (2). Areas of low productivity have been brought under cultivation, since the individual farmer can profitably cultivate more acres than before. One of the finest examples of this has occurred in the United States wheat regions. Because of dryness, yields of wheat are frequently under ten bushels per acre. Because of extensive, mechanized farming methods, however, a farmer can cultivate hundreds of acres. In this manner total production is sufficient to make it commercially profitable for the individual.

Mechanization of American farms has also greatly influenced the nation's social and economic structure. In 1960 at least ten million fewer persons were living on farms than in 1920, although national population had increased by more than 70 million. During that period the number of hired farmhands declined by more than two million. Farm population dropped from 29 to 11 per cent of the total, and farmers were using 23 million fewer work animals. Nearly 5,200,000 tractors were in use on 4,780,000 farms. Agriculture is thus undergoing an industrial as well as mechanical revolution.

WORLD PATTERN OF PRODUCTION AND USE

Anglo-America. The United States and Canada possess a highly mechanized farming economy. With about 16 per cent of the world's arable land these two countries have about 60 per cent of the world's tractors. There have been many reasons for the widespread use of power-operated machinery in North American agriculture. Large areas of land in both Canada and the United States have been opened up within the last century where prototypes of modern farm machinery were utilized. The general technological level of both countries is high and a vigorous farm machinery industry was established at an early date. The growing domestic and foreign demand for food and raw materials has in general ensured a good market and profitable prices for as much produce as could be grown —although there have been surpluses. A relative shortage of labor and high wage rates have both focused attention on the development and use of labor-saving equipment and in more recent years the use of tractors and other sources of power has been favored by ample supplies of low-priced petroleum products and by progress in rural electrification.

The United States and Canada are not only the greatest users of modern farm machinery but the largest producers of it as well. The combined output of the two countries in 1960 accounted for two-thirds of the estimated world production and three-fourths of the farm machinery entering world trade. The industry of the two countries is largely complementary. In Canada, for example, tractor production is limited mainly to smaller types and does not supply domestic needs for larger types, imported from the United States. On the other hand, small tractors, combines, and some implements are exported from Canada to the United States. The magnitude of this trade within the region is shown by the fact that in 1960 over 40 per cent of the total farm machinery exports of Canada and the United States were exchanged between these two countries.

Europe. With 12 per cent of the world's arable land and 20 per cent of its tractors, Europe is second only to North America in the total quantity of modern farm machinery in use. Farming in most countries is in an advanced technological stage, employing highly developed equipment suitable for animal and tractor power. There are also considerable areas in eastern and southern Europe where the wooden plow still persists, together with a flail and a winnowing fork similar to the implements used in the neighboring underdeveloped areas of Asia and North Africa. On the other hand, the countries of western and northern Europe are among the most highly mechanized in the world, with an appreciably more intensive use of modern power-operated equipment than in North America (18).

During World War II Europe lost 15 per cent of its draft animals, which before the war had contributed approximately 95 per cent of the farm power. At the end of the

war much of the region had deficiencies in tractor and horse-drawn plows, binders, sprayers, beet and potato harvesting machinery, and even simple hand tools.

Since 1950 there has been an expansion of facilities for producing farm machinery. European manufacturers now account for about one-quarter of the world's production of these items. The growth of the tractor industry illustrates the modern trend in the manufacture of farm equipment. Europe produces annually about one-half million agricultural tractors of all kinds, plus complementary equipment. Approximately 385,000 are wheel tractors, 100,000 walking and riding garden tractors, and 15,000 caterpillar (crawler) tractors. The lighter models of nine to 29 horsepower make up between 80 and 90 per cent of the wheel tractors produced. The principal producers of wheel and garden tractors are the United Kingdom, Germany, and France. Crawler tractor production, although relatively small, is dominated by Italy, the United Kingdom, and West Germany.

Soviet Union. The U.S.S.R. affords the classic example of a planned transition from one level of development in farming to another. Within the decade from 1928 to 1938 the agriculture of this region was in large measure transformed from a peasant system employing hand and animal tools to a collectivized system heavily dependent on tractors for tillage and on combines for harvesting, though still requiring much hand labor and employing many relatively backward techniques and implements for other farm operations. In the early stages of the intensive farm mechanization program, most tractors and other equipment were imported, mainly from the United States. However, as the program developed the machinery supplied to Soviet agriculture was increasingly provided by the domestic industry. Some idea of the magnitude of the transition achieved by the first two five-year plans, starting in 1928, can be gotten when it is noted that draft animals declined in number from 29 to 13.6 millions. By the Second World War Russia, with 18 per cent of the world's arable land, had 10 per cent of the world's tractors.

The invasion in World War II of a large part of the best agricultural land and the destruction of equipment and farm machinery plants was a serious setback to the Soviet economy. At the conclusion of hostilities the farm machinery industry was rapidly restored. The huge tractor plant at Kharkov and the combine plant at Rostov-on-Don were rebuilt from the rubble of destroyed buildings. The fourth five-year plan provided for the restoration of the prewar level of tractor production by 1950. New tractor factories have been built at Minsk, Vladimir, Libetz, and Volgograd. Manufacture of associated equipment has kept pace with that of tractors.

Latin America. Latin America as a whole represents an intermediate stage between the highly mechanized countries of Western Europe and North America and such areas as the Near East and the Far East where farming is still performed almost entirely with simple hand and animal implements. With some 9 per cent of the world's arable land, Latin America has roughly 3 per cent of the tractors in use in the world. These figures give an indication of the relative importance of mechanization in the region, although there are great variations from country to country and from area to area within individual countries (19).

Factory production within Latin America supplies only a portion of the demand for agricultural machinery. Although tractor production has only begun in Latin America, numerous producers make other items of machinery and equipment. Firms, notably in Argentina and Brazil, have started the assembling of tractors from imported component parts and will gradually undertake more complete production. Argentina has one of the most advanced agricultural machinery industries, producing such items as combines, seeders, drills, cotton strippers, and corn pickers. The domestic industry has been encouraged by placing import restrictions on agricultural machinery. Other countries with an agricultural machinery industry include Brazil, Chile, Uruguay, and Mexico. Production is still on a small scale, and Latin America depends to a large degree on imported machinery.

It is extremely important in a region where most of the farmers have a low income that simple tools be provided to promote a higher

level of agricultural production. For example, a recent study revealed that about 60 per cent of Brazil's total agricultural production is obtained exclusively by manual labor.

Australia and New Zealand. Great land resources along with a small population and a high standard of living have resulted in a significant mechanization of these areas. This region has about 1.5 per cent of the world's arable land and about 2 per cent of the world's tractors—about the same ratio as in Europe. Both Australia and New Zealand have a small but well-developed domestic farm machinery industry. In Australia the industry specializes in large tillage, seeding, and harvesting equipment for the production of wheat and other small grains. Some of the machinery is of original design suited to local conditions. In New Zealand the industry is smaller and produces a more restricted range of products. Tractor production has begun in Australia, and is now about 2,000 units a year.

Asia and Africa. The use of power-operated farm machinery in these two continents is limited. The Far East, with about 23 per cent of the world's arable land, has less than 5 per cent of its tractors. Furthermore, the slow rate at which this type of machinery is being adopted is shown by the fact that the region has received only 2.5 per cent of the total value of tractors and other farm equipment entering world trade and has about one per cent of the total world production of these items.

Native agriculture in most of Asia still depends on the use of hand tools supplemented by animal-drawn equipment of simple design such as the wooden plow. In some areas, however, long association with the industrialized countries of Western Europe and more recently North America, has led to the introduction of steel plows. In a number of countries—in recent years, notably Japan and Israel—power-operated equipment has been successfully applied. Local industries largely supply the traditional equipment of the small farmer, but most of the improved animal-drawn implements, tractors and associated implements are imported.

Of the Asian countries, Japan has possibly the best developed agricultural implement and machinery industry. It is composed of more than 900 farm machinery companies, and as many as 20,000 small forging or blacksmith shops producing hand implements on a full or part-time basis. Although Japanese manufacturers produce some wheel and crawler tractors, most of their capacity is concentrated in the production of garden tractors and rototillers. One popular tractor has a detachable engine mounted high in the front so that it does not become immersed in the paddy-field water. When the tractor is idle the detachable engine is used for power threshing and hulling or as power for other farm machinery (21).

The only parts of Africa where power-operated farm machinery is in general use are northern Africa and the Union of South Africa. Only a small proportion of the land is under cultivation and primitive methods are usually applied. Small factories for the production of certain equipment have been developed in northern Africa and in the Union of South Africa, but the continent is dependent on imports for the more complex types of machines. Native craftsmen produce some of the tools used in village agriculture.

UNITED STATES

Farm mechanization has advanced rapidly in recent decades in the United States. On January 1, 1910 the value of agricultural implements, including automobiles, tractors and motor trucks, amounted to about $1,200,000,000. On January 1, 1961 all machinery on farms was valued at more than $18,000,000,000. During recent years sales of farm machinery, including tractors, have been at the annual rate of $2,000,000,000 to $2,500,000,000. The rise in value of farm machinery since 1910 has been largely because of the increase in mechanical power on farms. In 1961 there were in the United States over 5,200,000 tractors and 40 million other farm machines.

Factors of localization. Physical and economic factors greatly influence the production and sale of farm implements. The quantity and type of farm machinery sold to farmers depends upon the development of an agricultural system which is prosperous enough to provide the farmer with enough capital to invest

in labor-saving machinery. The growth of this system depends on a great number of factors.

There are in the United States today about 4,800,000 farms with an acreage of 1,150,000,000. The average farm is about 155 acres in size. In the United States approximately 81 per cent of the farms are under 175 acres, about 40 per cent are under 50 acres, and slightly over 18 per cent under 20 acres. This means that there are fairly wide regional differences in the size of farms. For example, in the West North Central states approximately 60 per cent of the farms are under 175 acres. Not only must the farm machinery manufacturer produce implements for all sizes of farms, but many farms are so small and their productive capacity so limited that very little money is available to purchase machinery.

The availability of farm land for raising crops is a limiting factor in the sale of farm implements in many farming areas. Of the more than 1,150,000,000 acres of farm land in the United States only about 60 per cent is available for crops and the remainder is used for pasture or woodland. The bulk of the demand for farm implements in the United States comes from those areas where farm lands are planted in crops that require annual planting, cultivating, and harvesting.

The physical factors of climate, topography and soil have greatly affected the extent and direction of agriculture and the type and kind of farm implements used by farmers. To be adaptable for farming, an area must not be too hilly or stony for cultivation, it must have sufficient rainfall to grow a crop, its soil must be fertile enough that production costs are reasonable, and its growing season must be long enough to permit a crop to mature. Limitations imposed by physical factors are readily apparent from the fact that of the 1,903,000,000 acres of virgin land in the United States, approximately 500 million could have been used for crops and pasture, another 500 million acres were suitable for pasture only, and about 75 million acres were suitable for pasture or forest.

The prosperity of the farmer and that of the farm implements manufacturer are closely related because farm income directly influences the farmers' operating expenditures and the extent to which efficient farm management practices may be used. Decreased costs of farm production depend quite largely on the farmers' ability to purchase the most efficient implements and machines. In the United States, 53 per cent of the farms in the 16 southern states are tenant-operated while only about 31 per cent of the farms in the northeast are operated by tenants. In relation to farm income the Northeast has about 50 per cent of the total farm income and the South about 30 per cent.

New and improved agricultural implements introduced from time to time have played an important part in the steadily increasing productivity of the American farmer since colonial times. Farming techniques have undergone a complete revolution in the United States since 1800. At that time farmers were still largely employing the techniques of the Old World. However, the development of machinery is not equally advanced for all branches of agriculture. For example, the machinery for planting and harvesting grains is quite advanced, while, the machinery for the cotton farmer has been slow to develop.

Also important to the localization of the farm machinery industry are factors applying directly to its manufacture such as the availability of raw materials, a well-developed industrial region, and facilities for distributing the finished products. The farm implement industry is a major consumer of raw materials and partially manufactured products. Between 40 and 45 per cent of the value of farm implements is given to raw materials. Of the materials consumed between 65 and 75 per cent is iron and steel, 5 to 10 per cent lumber, and 15 to 30 per cent other materials. Thus, the locating of the farm implement industry in an industrial area which can supply raw materials, particularly steel, and other manufactured products is extremely important.

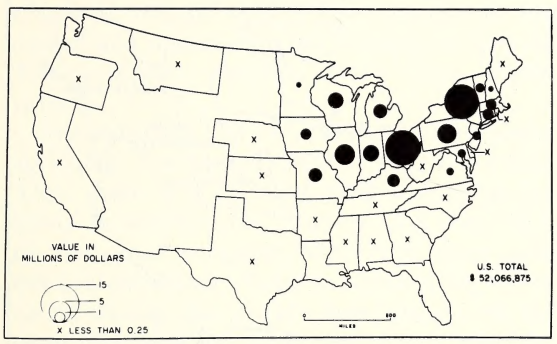
The manufacturer also prefers to establish his plant near the market center because of the high freight rates charged on farm machinery. This high rate is principally due to the large amount of car space occupied by equipment when assembled at the factory.

It is difficult to evaluate each of the above mentioned factors, but it is the collective impact of all physical and economic conditions

on the more than 4,800,000 farm operators in the United States that finally determines the demand for agricultural implements and machines. The ideal location for the farm machinery industry is a well-developed industrial region close to a prosperous farming area.

Location of the industry. The agricultural machinery industry developed in this country in the lower Great Lakes states. Since 1850 this region has produced more than 75 per cent of the nation's farm machinery. Because the center of the farm implement industry has tended to localize near the center of agriculture, there has been a gradual westward migration of production.

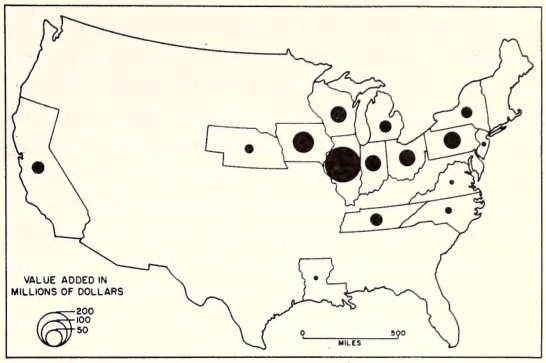
Between 1840 and 1870 New York was the largest producer of farm implements followed by Ohio and Illinois (Map 12.1). By 1880 Ohio



12.1. United States — Agricultural Machinery Production—1870.

had become the leading state followed by Illinois and New York. The supremacy of Ohio was short-lived, for by 1890 Illinois had assumed leadership, a position it has maintained to the present. Since 1890 Illinois has produced between 30 and 40 per cent of U. S. farm machinery. New York and Ohio have declined in recent years, each producing 4 to 8 per cent of the country's output while Indiana and Wisconsin have increased their share of production, each having 6 to 15 per cent of the nation's annual output.

In the 1958 Census of Manufactures the East North Central and the West North Central states had 75 per cent of the farm machinery industry (Map 12.2). The Northeastern states had an additional 10 per cent



12.2. United States — Agricultural Machinery Production—1958.

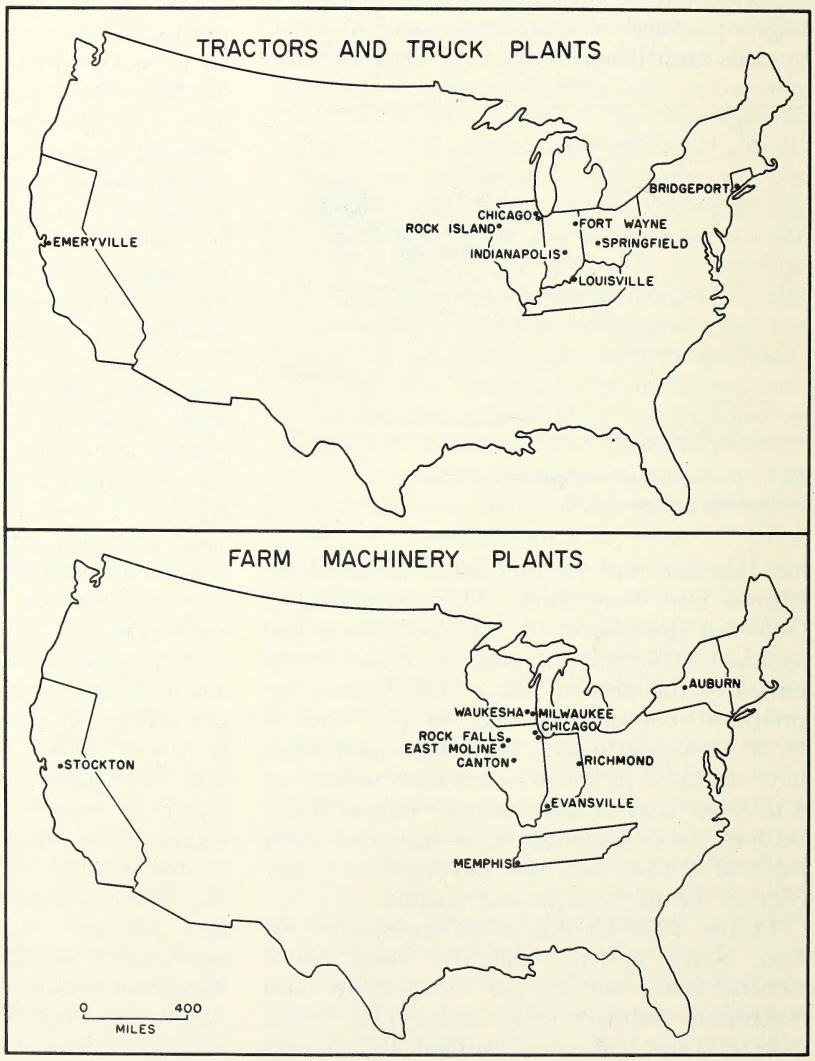
of the output with Pennsylvania being the largest producer in this region. The South produces about 9 per cent of the nation's farm machinery. There is growing activity on the Pacific Coast, particularly in California, with specialization in machinery especially adapted to that region.

Centralization of the industry. Within the producing districts there has been a gradual centralization of the industry at a few major locations of manufacture. The early growth of the farm implement industry saw the development of machine after machine by individuals or partnerships, each owning or controlling one or more basic patents. As a result a multitude of small single-line companies developed in a great number of places. As trade names became important in selling equipment the small firms began to disappear. With the decline of the small firms the larger firms concentrated their manufacturing plants in order to secure as near optimum locations as possible.

As a result manufacturing concentrated in a few places. In New York, Auburn assumed leadership. In Ohio, Dayton and Springfield were the leaders, and in Illinois the center was Chicago with lesser concentrations in Peoria, Rockford, and Decatur. The greatest single center of farm machinery production in the United States is Chicago. It gained this dominant position largely between 1890 and 1900 and since then has been producing between 20 and 25 per cent of the country's farm machinery. Major centers which have developed since 1900 are Racine and Milwaukee in Wisconsin.

International Harvester Company. Although there are approximately 60 companies manufacturing farm machinery in the United States today, five companies—International Harvester Company, Allis-Chalmers, Deere and Co., J. I. Case Co., and Massey-Harris-Ferguson, Inc.—produce approximately 90 per cent of the total output. Of these companies International Harvester is by far the leading producer of farm machinery and tractors, and also ranks as one of the important manufacturers of motor trucks, industrial power equipment, balers, and binder twine (Map 12.3). In 1959 this company produced $643,610,000 worth of motor trucks and $458,850,000 of farm implements and services. The total value of all products produced in 1959 was $1,363,166,000, which is about 50 per cent of the total value of farm machinery sales in the United States.

International Harvester has a world-wide organization. In the United States its main plants are located in the Chicago area. Other plants serving the midwestern region are located in East Moline, Rock Island, Canton, Rock Falls, Libertyville, and Melrose Park, all in Illinois; Richmond, Fort Wayne, and Indianapolis, Indiana; Milwaukee and Waukesha, Wisconsin; and Springfield, Ohio. Other regional plants include those in Louisville, Kentucky; Memphis, Tennessee; New Orleans, Louisiana; Bridgeport, Connecticut; Emery-



12.3. United States—International Harvester Company.

ville and Stockton, California; and Auburn, New York. Subsidiaries of the company own three plants in Canada at Hamilton and Chatham, Ontario; three in England at Doncaster, Bradford, and Liverpool; two in France at St. Dizier and Montataire; two in Australia at Geelong and Dandenong; and one each at Norrköping, Sweden; Neuss, Germany; Saltillo, Mexico; and Santo André, Brazil.

Besides these manufacturing plants International Harvester has other important holdings. The company owns a steel mill and a by-products coke oven located at South Chicago with an annual capacity of 664,000 net tons of coke, 730,000 net tons of pig iron, and 1,200,000 net tons of steel ingots. Iron ore comes from iron mines in the Lake Superior region of Minnesota. The company also owns 6,507 acres of coal land in Harlan County, Kentucky with an annual production of about 700,000 tons. Fiber plantations are owned and operated in the Philippine Islands. The company employs more than 95,000 workers.

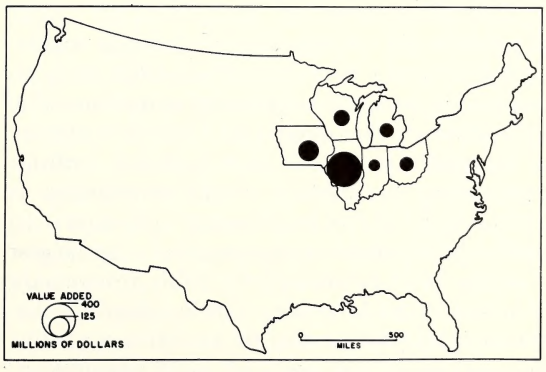
International Harvester is the greatest single agricultural machinery enterprise in the world. That there is a growing food supply in the world is attributable more to this firm than to any other company, especially since agricultural machinery itself has been a big factor in increasing the world's food supply in the twentieth century. It is estimated that this company has 4 million customers annually. Having made the machine the foundation of modern agriculture, International Harvester has tried to produce the best machines, the most important machines, and the greatest number of them.

Development of the farm tractor industry. The use of the tractor as an agricultural implement has been developed largely since World War I. Because they lacked maneuverability, the early tractors were used almost exclusively for heavier farm work such as plowing and disking. This type of tractor was developed by the automobile industry and particularly by Henry Ford. In most instances the early tractor was built in the same plant that produced automobiles. In 1920 the Ford Motor Company produced about 70 per cent of U. S. tractors.

In 1924 the International Harvester Company introduced the first all-purpose tractor. It was an immediate success and production by the automobile companies declined. By 1928 all automobile companies, including Ford, had discontinued manufacture of tractors. (Ford, however, resumed production of tractors after World War II.) The four major reasons for this withdrawal appear to be that the market for tractors required a markedly different selling program and approach than for automobiles; tractors without a related line of farm implements are difficult to sell in volume; the conditions and methods of tractor use demand an entirely different engineering approach, even though superficially there seems to be much in common between tractors and automobiles; and finally, nearly all larger farm implements had to be redesigned to make them strong enough for the greater draft power of the tractor. The simultaneous development of tractors and equipment could best be achieved at a single center of production by companies whose prime function was the manufacture of farm machinery.

With the introduction of the all-purpose tractor production increased greatly. Even during the depression of the early 1930's the number of tractors sold was significant. In the middle 1930's the rubber tire was introduced, enlarging the tractor's uses, and production again underwent a sharp increase, rising from 156,858 in 1935 to 208,685 in 1939.

Since 1945 the production of farm tractors has continued to increase (Map 12.4). This expansion stems from a number of factors.



12.4. United States—Tractor Production —1958.

Because of shortages and high-cost farm labor since World War II there has been a great impetus to mechanize American agriculture. More than one million farm workers who were in the armed forces or employed in war industries did not return to agricultural employment at the war's end. At the same time work animals have been decreasing, through competition with mechanization. But this has also meant fewer substitutes for mechanical power. Thus, there has been a demand for greater productivity enabling one man to perform the work for which several were required in prewar years. Since 1945 there has also been the development of light, eight-horsepower tractors which can be used on small farms.

Because of the demand for tractors, the value of output from 1939 to 1958 rose from $244,000,000 to $1,635,000,000. The tractor portion now accounts for more than 50 per cent of the total production of farm implements. The production of tractors continues to be found in the states that produce farm machinery. In 1958 the East North Central and West North Central states produced 90 per cent of U.S. tractors, measured by value added. Illinois has the greatest production, with approximately 50 per cent of the country's total, followed by Iowa with an additional 15 per cent. The South and the Northeast have 6 and 2 per cent of production, respectively. There is only a small tractor industry on the West Coast.

CANADA

Canada is one of the most important excess-food producing nations in the world, with an annual billion-dollar agricultural income. The agricultural development of Canada's vast interior would not have been possible without laborsaving machinery. Farm machinery is one of Canada's oldest factory industries. In 1947, Massey-Harris-Ferguson, Ltd., the largest manufacturer, celebrated its 100th anniversary (10). Stimulated by the development of machinery designed to save more and more labor in a country of vast area and small population, farm equipment sales have increased greatly in recent decades. Annual sales of farm machinery in Canada are between $100,000,000 and $150,000,000.

The farm machinery industry is predominantly located in southern Ontario. The industry has capital assets of over $100,000,000 of which more than 95 per cent are invested in plants in Ontario. Three companies—Massey-Harris-Ferguson, International Harvester, and the Cockshutt Plow Company—dominate production. The principal centers of production are Hamilton, Brantford, and Toronto, while London, Chatham, Sarnia, Woodstock, and Smiths Falls also have farm machinery plants. Peninsular Ontario is well situated for the development of the farm implement industry. Not only is this an important agricultural area, furnishing a regional market, but it is the most important industrial area in Canada.

The agricultural implement industry contributes greatly to the country's general economy (17). It consumes annually more than $50,000,000 worth of raw materials and partially manufactured items. The industry purchases between 125,000 and 150,000 tons of metal castings annually. Because of its basic requirements the Canadian farm machinery industry, as in most other countries, is a part of its chief industrial region.

Although all other farm machinery centers in Canada are small, several trends are significant. Until the early 1940's Quebec had always been second to Ontario in production; but in that year it was supplanted by Manitoba. The westward migration of farm machinery production illustrates the need for machinery on the large grain farms of the Prairie Provinces, as well as the development of new interior industrial centers where agricultural machinery can be manufactured. An important stimulation to increased farm mechanization in this region has been the growing size of the individual farm. In Saskatchewan the family-sized farm has increased from about 480 acres to over 1,000 acres since 1925. Partially as a result of this development, the number of tractors increased in this province from 42,000 in 1936 to 72,000 in 1946, and by 1960 there were over 250,000 tractors in use.

The center of farm machinery production in central Canada is Winnipeg, with minor centers at Calgary and Edmonton. Although

central Canada is primarily an agricultural region, the area still lacks supporting industries for a well-developed farm implement industry.

A small farm machinery assembly industry, serving the local area, is located in Vancouver.

SOVIET UNION

Although the U.S.S.R. was traditionally an agricultural nation, production of farm implements in tsarist Russia was on a small scale and at a low technical level. Although there were more than 700 establishments in 1910, most of these were semi-handicraft enterprises manufacturing simple horse-drawn and hand tools. Approximately 45 per cent of the agricultural machinery used in Russia prior to the Revolution was imported.

The agricultural machinery industry was in an almost complete state of disorganization after the Revolution. Its reconstitution, however, was among the first industrial plans initiated by the Soviet state. By 1926 prewar production of farm implements had been considerably exceeded. At this time the agricultural machinery plants were located in the older industrial centers of Leningrad, Moscow, Ryazan, and Gomel. There were few farm implement factories in the southern grain belt of Russia.

With the introduction of the first five-year plan in 1928 a radical reorganization and expansion of the industry was instituted. The transition in production from simple tools to complicated machines for mechanical traction took place rapidly. This trend was hastened after 1929 by the rapid development of the collective and state farms, when a demand was created for large tractor-drawn equipment. Consequently, under the planned economy of the Soviets a large number of new agricultural machinery factories were established in new locations. These centers were located in respect to their agricultural market and to the availability of raw materials, particularly iron and steel.

Because emphasis was placed on the production of grain—particularly wheat—in the U.S.S.R., the most striking development of new farm machinery factories occurred in these regions (14). As the program was instituted there was an immediate need for power-operated farm equipment. Consequently, in 1930 and 1931 the large tractor plants at Volgograd and Kharkov were completed. Under the first five-year plan between 1928 and 1932, it is estimated that 115,000 tractors were produced. During this period the Ukraine became the major area of farm machinery production with important centers at Kharkov, Zaporozhye, Kirovograd, Odessa, Kherson, and Osipenko. Other farm machinery centers developed during the first five-year plan at Rostov to serve the north Caucasus area and Saratov, serving the Volga region. Small centers were also started at Omsk, Orel, and Chelyabinsk.

As Soviet agriculture expanded eastward, the traditional farm machinery centers were enlarged and new ones developed. Under the second five-year plan, work was begun on a large tractor plant at Chelyabinsk, the gateway to the agricultural areas of western Siberia and the southern Urals. In 1940 a factory was built at Irkutsk to supply central Siberia with agricultural machinery. At about the same time a plant was erected at Khabarovsk to service the Amur River country of eastern Siberia.

In a number of places factories were established to produce speciality machinery for a particular region. For example, machinery for cotton production is made in Tashkent, and the manufacture of flax and potato cultivators is largely limited to such centers as Rzhev, Ryazan, and Moscow.

Between 1920 and 1939 it is estimated that agricultural machinery production increased more than 40 times. In 1939 there were 17 major manufacturing centers. During World War II the industry received a severe reversal when western Russia and the Ukraine were conquered by Germany. Production was shifted eastward but lagged far behind demands for new farm machinery. In the fourth five-year plan, starting in 1946, emphasis was once again placed on rebuilding the centers damaged by war and a renewed expansion of interior plants. By the end of 1947 the Soviet Ministry of Farm Machinery Production indicated that farm implement output was 133 per cent more than the prewar level, and by the end of 1948 output was 200 per cent

above the prewar figure. Agricultural machinery production was stressed in the 1950's and output continued to rise. The industry remains localized in the agricultural regions and the metallurgical centers. Thus, markets and raw materials have played dominant roles in localizing the industry.

UNITED KINGDOM

A significant growth of an agricultural machinery industry in Great Britain was long delayed (15). The demand for farm implements was not large, partly because of the smallness of the country and partly because in the last half of the nineteenth century Great Britain directed its energies toward the development of manufacturing, with the resulting abandonment of much of her agricultural land. Thus, implement manufacture was largely developed by blacksmiths and wheelwrights in small, widely distributed shops, with some form of manufacturing being found in every county in England.

This dispersal of the industry was encouraged by a number of other factors. The amount of raw materials consumed was quite small, and since production was largely by hand operations, the weight and value of materials as a percentage of the gross product value was also small. Because of the large number of manufacturers the British have always produced a wide variety of machines to meet local conditions. While the country is small in size there are many local variations in the physical environment which require specialized implements. For example, the production of heavy, wet grains on the east coast makes it necessary to produce machines for these particular conditions. Local specialization discouraged the development of large factories serving the entire country.

At about the turn of the present century a number of agricultural implement centers, almost invariably located in rural areas, began to produce a greater share of the machinery. This early concentration in towns like Ipswich and Stamford appears to have developed as a result of a growing export market for British farm implements to northwestern Europe. The Census of Production of 1907 indicates that 75 per cent of the British output was exported. This export trade was short-lived, and with the development of farm machinery factories in Europe, British export declined sharply after the First World War.

The scattered origins of the industry remain evident in the modern geographic structure, although contemporary developments are causing the concentration of a growing proportion of the output in a few centers. Although 800 firms still manufacture agricultural machinery of some type, 65 firms in 1960 had over 90 per cent of the total wage earners. The agricultural machinery industry is not a large employer. Omitting tractors, the labor force totals only about 42,000 employees.

The greatest concentration is in the Midlands, with about one-third of the total labor force. The East and West Ridings area of Yorkshire is second with slightly less than one-sixth of the labor force. Employment in London and the southeastern area increased more than fourfold from 1935 to 1946, largely as a result of the Ford Motor Company's tractor works at Dagenham. The development of the larger centers is in part due to expansion of companies such as International Harvester at Doncaster, Massey-Harris-Ferguson at Trafford Park, and David Brown at Farley, near Leeds. The development of the large factory is a response to recent attempts to expand British agriculture. Since 1950 this industry has undergone a process of expansion and reorganization at a faster rate than that of almost any other branch of British engineering. As a consequence Great Britain in the postwar period has been one of the largest producers of farm machines in Western Europe.

At least five factors combine to make the domestic demand for British agricultural machinery greater than at any previous time. Because of the demand for increased domestic agricultural productivity more land has been brought under cultivation than in any period since 1870. Because of the dollar shortage in Britain, imports of farm implements have been small, so that almost the entire problem of mechanizing the farms has fallen to the British industry. Also important is the fact that farm machinery exporting countries like

the United States and Canada do not produce farm implements designed for the small British farm. There are only 14,000 farms in Great Britain of over 300 acres in size, while 194,000 out of 358,000 farms of more than five acres are under 50 acres. There has also been a definite trend toward mechanical power, with a gradual decline in the use of horses. The shortage of agricultural labor and the great demand for food created a need for mechanization in order to save time, labor, and costs. A fundamental problem in this change has been that many of the farms are too small for the farmer to be able to afford expensive machinery. Beginning in World War II the joint use of machinery through the medium of regional pools has considerably reduced this problem. Lastly, the general policy of the government as expressed by the Ministry of Agriculture and Fisheries has been, both during the war and since, the encouragement of expansion to supply the domestic market as well as for export. In order to secure sufficient expansion in the production of agricultural machinery it has been necessary to enlarge existing firms and encourage the entry of other British engineering firms into the industry, particularly those who can work with established manufacturers. Foreign manufacturers have also been encouraged to build plants in Britain.

A number of changes are occuring in the type of farm machinery produced and, consequently, in the pattern of production. Two trends are readily discernible, both relating directly to the development of the tractor industry. The first is the introduction of mass-production methods, coming largely from the automobile industry and aiming to increase output to a level far beyond anything hitherto attempted. The second is a rapidly growing integration between tractor and implement manufacturers.

The location and expansion of tractor manufacture are playing an increasing role in determining the distribution and organization of the industry. Tractor production in recent years accounts for about 40 per cent of the total value of farm implements manufactured. The annual average production of tractors from 1937 to 1940 was 14,000 units, of which the Ford Motor Company produced over three-fourths. During the war years, 1940 to 1945, the Ford Motor Company produced over 120,000 of the 128,000 tractors manufactured in Great Britain. Until the close of World War II tractor production was centered at Dagenham where the Ford automobile industry was also located.

Since World War II production has continued to increase and several prominent automobile manufacturers, notably Standard Motor Co. and the Nuffield organization, have entered the tractor business. Tractors are now produced at the rate of about 120,000 annually. The number of centers producing tractors has consequently been enlarged. The principal new centers in England are Coventry, Leeds, and Doncaster, and, in Scotland, Kilmarnock. It is thus evident that the tractor industry is attracted to the automobile industry in certain areas but also to the farm machinery industry in others.

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CHAPTER THIRTEEN

PETROLEUM REFINING INDUSTRY

The world's petroleum refining industry has had an uninterrupted expansion since the first oil well was drilled in 1859. The growth of the industry can be divided into two distinct periods—the kerosene and gasoline eras. The kerosene era extended from 1860 to about 1900, when the principal use of petroleum was for illumination purposes. Because the markets for petroleum products were limited, the refining industry grew slowly during this period. By the turn of the century the world demand for petroleum was only about 400,000 barrels daily, of which nearly 60 per cent was consumed in the United States.

The gasoline era from 1900 to the present developed largely from the use of the internal combustion engine. Although transportation industries consume about 80 per cent of the petroleum products produced today, other markets have been developing, such as domestic heating, industrial uses, and as a raw material in an expanding chemical industry. These market demands have resulted in a phenomenal rise in petroleum production.

Between World War I and World War II the world consumption rose from 1,500,000 barrels to six million barrels daily. By the end of World War II total consumption had climbed to 7,800,000 barrels daily. To the surprise of most petroleum specialists the demands since 1945 have continued to rise and in 1960 reached the staggering total of 23,800,000 barrels daily. The United States consumes about 40 per cent of the world's petroleum, the volume being about 9,450,000 barrels per day. Since 1946 U. S. consumption has increased by about 4,550,000 barrels per day. This increment alone compares with a total demand in Europe, excluding the Soviet Union, of 3,500,000 barrels per day in 1960.

PETROLEUM REFINING PROCESSES

Refining processes have changed radically in recent decades, from the large-scale application

of simple distillation methods in vogue until about 1915 to the complex chemical operations of today (2). Fundamentally, the changes in techniques have been marked by a shift from a relatively elementary physical process to a physical-chemical approach which requires the highest skills of the chemist and engineer.

The early crude distillation process was relatively inflexible as to percentages of different products obtained as the oil was heated. Generally, only 18 to 25 per cent of crude petroleum was converted to gasoline with octane ratings between 40 and 60. Before the automobile, it was desirable to create as little gasoline as possible, the production of kerosene being the prime interest.

In order to meet the demand for gasoline that developed with the increased use of automobiles and still not flood the market or waste a great deal of fuel oil, processes have been developed which convert the heavier oil fractions into lighter hydrocarbons of the gasoline type. Thermal and catalytic cracking processes are now widely used for this purpose. These processes convert the heavier hydrocarbons to lighter hydrocarbons through the application of heat and pressure. As a result the percentage of crude oil converted to gasoline gradually increased from 25 per cent of the total in 1918 to more than 50 per cent in the 1950's, at which level it has remained.

Since 1940 auxiliary units for producing specific products have been installed at many refineries. These processes, such as polymerization and hydrogenation, are in addition to the basic processes. They serve to improve the quality of the gasoline produced by distillation and thermal or catalytic cracking methods, and also to convert certain volatile hydrocarbons into liquid products which are released by, but not liquified in, the three basic processes.

LOCATIONAL FACTORS

The two greatest influences on the location of the refining industry are the availability of crude oil and the market. A refining industry has developed in all major and most minor petroleum producing regions. Within such a region plants may have one of two locational aspects. The first can be the pool location, which places the refinery close to the wells of individual geologic oil structures. This type of location is typical of newly developed fields. Because the supply of oil is frequently small, and in view of the early exhaustion of such pools, these refineries operate on a small scale. The early oil refineries of the 1860's in the oil region of western Pennsylvania were an example of this type of location. The second locational aspect is the field refinery, which gathers its crude oil from many different pools in an oil field and which can therefore resist the exhaustion of individual pools. Many refineries with this type of location exist, for example, in the Midcontinent oil province (the oil fields of Kansas, Oklahoma, Arkansas, northern and west central Texas, and northern Louisiana).

One of the considerations in locating a refinery near the source of crude oil concerns transportation costs. An average refinery burns and loses 6 to 10 per cent of its crude oil supply as refining fuel and waste. By locating the refinery close to a crude supply and shipping only products, a considerable reduction is made in transportation costs. The transportation of crude oil can add very appreciably to its cost at the refinery.

Most of the world's oil fields do not coincide with large consuming areas. For example, in the United States 80 per cent of the crude oil is produced in the Midcontinent and Gulf Coast provinces, although approximately 80 per cent of total U. S. consumption is in northeastern United States. In the last 20 years one of the significant trends in refinery location has been the building of larger refineries oriented toward markets instead of sources of crude oil (4). The normal location of such plants is at a convenient breaking point in transportation and yet as close as possible to the geographic center of the market. Philadelphia and Montreal refineries are typical of this type of location.

The seaboard export refineries are also market oriented. These refineries are located at ocean shipment breaking points and rely on crude oil from one or more oil regions. Delivery of products to one or more markets takes place by cheap ocean transportation.

The Gulf Coast refineries of the United States and the coastal refineries in the Middle East illustrate this mid-point type of refinery location.

Besides these influences on the location of the refining industry, a number of other factors affect refinery location. The increasing complexity of the refining process, which originated with the introduction of thermal cracking, has resulted in larger units. The relative inefficiency of small operations in modern processing has led to the virtual elimination of pool-type refineries as well as a reduction in the number of field-type refineries. Almost no small plants are being built and those which remain were established in an earlier period of the industry.

In recent years there has developed a large number of finished-product pipelines. Refineries, which have the facilities of a finished-product pipeline, have an enlarged market and consequently can compete with refineries in areas which market their product by rail or truck. Finished-product pipelines particularly aid the field refineries, but also enlarge the sales area of market-oriented refineries. In recent years the consumption of fuel oil has increased at a rate higher than for most other petroleum products. Fuel oil, owing to its high relative bulk and corresponding difficulties of distribution, has a tendency to encourage market location of refineries.

The increasing utilization of by-product gases as well as natural gases in various chemical processes associated with petroleum refining appears to favor the field location of refineries in this country. However, in less industrialized countries this development may encourage additional refining capacity at market location.

The location of a refinery in certain regions of the world may be determined largely by governmental action and political conditions. In Italy and France the government has influenced refinery location by granting sales quotas to companies only if refineries were built at specified locations. These same countries have granted preferential import taxes to particular refinery locations. As a result companies sometimes build refineries not to serve new markets but to avoid losing an existing market area.

SITE FACTORS

Because of the nature of petroleum refining the selection of a good site is a prime requisite. As a first consideration, a refinery, with its many units and the considerable space occupied by its storage tanks needs an area of considerable size. The smallest plant requires more than 100 acres, and the larger plants frequently require more than 1,000 acres. Since this is an expanding industry, the availability of additional space must also be considered when a new plant is erected, as well as the cost of the land required.

The modern refinery should be so situated that there can be a gravitational flow of oil from one unit to the next. Thus, the tank farm should be placed on the highest ground and the loading platform for the finished products on the lowest ground. For example, if the plant is on the coast and most of the products are exported, a surface sloping gradually to the water's edge is desirable. If rugged land is the only type available the storage tank farms are normally located on the highest ground. If the refinery is situated along a stream in a narrow valley, the possibilities of flood should be investigated. A flood in an oil yard can have disastrous consequences.

The availability of an adequate water supply is essential to refinery operations. It is frequently said among refinery men that a refinery can never have too much water. The importance of cooling water for the refinery operations, potable water for personnel, and pure water for boilers requires that a thorough study of the water situation be made at the time the refinery site is selected. The amount of water required varies with the type of plant and the temperature conditions of the area's water. Twice as much cooling water will be needed if its temperature is 85°F instead of 60°F. In some locations the amount of water needed can be reduced by the use of cooling towers. In other areas, such as regions of high humidity, the effectiveness of such towers is greatly reduced. In some areas, the water will have too high a silt or alkali content for effective use in many refinery operations. A supply of pure water is necessary for boiler and treating depart-

ments. This is normally about 30 per cent of the total amount required. The remainder may be low grade, such as salt water, for cooling condensers, fire fighting, and general use. For a simple refinery with a 25,000-barrel daily capacity, the pure cooling water requirements may be 15 million to 30 million gallons per day. This is more than the flow of a small stream. To take so much pure water from the local population and return it to a stream as warm, polluted water is not only impractical but illegal in certain places.

Air pollution is another problem which influences the desirability of a refinery site. The prevailing winds, the frequency of atmospheric inversions, and the possibility of smog pockets are important aspects in air pollution. If a community is subject to air pollution from refinery operations, the industry is likely to be subject to local controls. Although air pollution can be controlled, its control is frequently expensive. For example, it is costly to remove the sulphur precipitates from high towers.

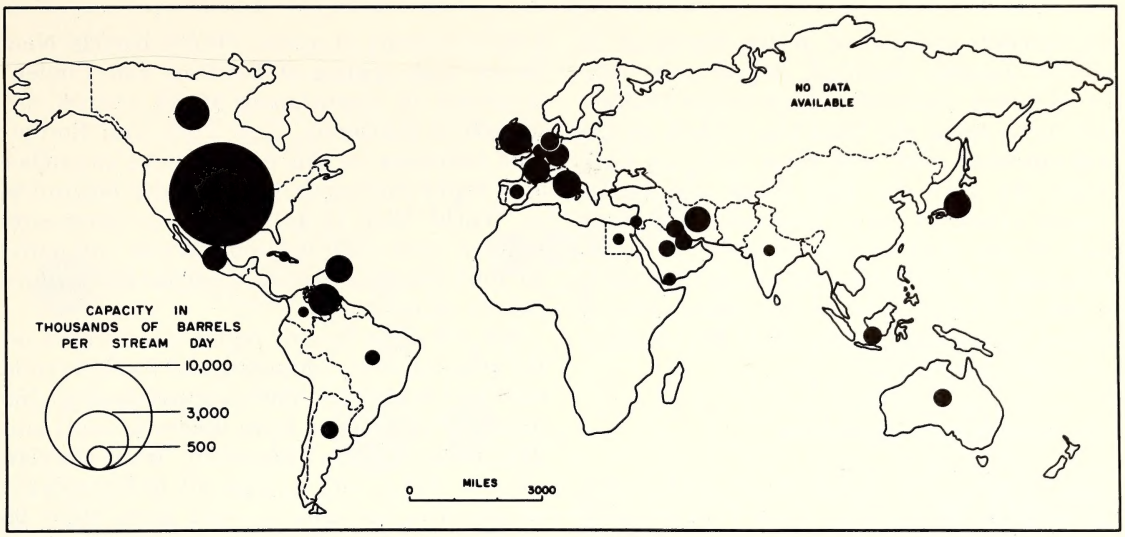
One of the most difficult problems in selecting a refinery site is the disposal of waste products, which frequently carry chemicals and refuse oils. In the past many refineries were located on streams and during high water stages the sludge pits were opened and the water allowed to wash the wastes away. This, however, caused extreme pollution, killing fish and destroying the usefulness of the water for towns further downstream. Because most states now prohibit this type of waste disposal, large areas must be provided for the construction of settling pits in which the waste is absorbed.

The availability of transportation facilities is of importance in selecting a site for a refinery. Because of the tremendous quantity of petroleum processed, the selection of a particular site may reduce transportation costs considerably. The cheapest method of transport is by tanker. Pipeline operations generally are more expensive than water transport, except in the case of small barges on inland waters. Railroad transport is the most expensive method, with the exception of tank trucking on highways. The latter is used only for the shortest hauls of finished products. In order to take advantage of the cheapest assembly of crude oil and the marketing of finished products, refineries are located whenever possible at ocean or lake sites. Such a site requires a good harbor plus docking facilities. At the same time marketing of the finished products in the immediate area usually demands adequate railway and highway facilities.

WORLD PATTERN OF PETROLEUM REFINING INDUSTRY

In 1960 approximately 8,600,000,000 barrels of crude oil were refined in the world. This was an increase of about 6,025,000,000 barrels over the 1945 output. The refining industry is found in more than 40 countries and the world's refineries as of January 1, 1960 had a capacity of about 23,450,000 barrels daily. Although the industry is widely dispersed throughout the world, two regions in the Western Hemisphere—the United States and the Caribbean—and three regions in the Eastern Hemisphere—Western Europe, the Middle East, and the Soviet Union—have approximately 90 per cent of the world's total refining capacity (Map 13.1).

Western Hemisphere. The refining capacity of North and South America in 1960 was approximately 13,580,000 barrels daily, about 60 per cent of the world's total. The United States is the world's largest producer of petroleum, with an annual output of between 2,400,000,000 and 2,600,000,000 barrels. With its 293 refineries and a daily crude capacity of 9,735,000 barrels in 1960 this country has about 72 per cent of the refining capacity in the Western Hemisphere and approximately 42 per cent of the world's total. The Caribbean area—with major refineries in the Netherlands West Indies and Venezuela and lesser centers in Trinidad and Colombia—is the second largest region in the world, with a daily crude capacity of 2,280,000 barrels. This is about 10 per cent of the world's total capacity. The petroleum refining industry of Canada is expanding rapidly, and now totals a daily capacity of about 945,000 barrels. Mexico and Argentina have fairly well-developed refining industries, and small centers exist in Bolivia, Brazil, Chile, Ecuador, Peru, and Uruguay.



13.1. World—Petroleum Refining Capacity—1960.

Eastern Hemisphere. The Eastern Hemisphere, with a daily crude capacity in 1960 of 9,725,000 barrels, has about 40 per cent of the world's refining industry. The refining capacity of individual countries in Western Europe is relatively small, but as a single region it has the largest capacity in the Eastern Hemisphere and stands second to the United States in the world. This region has had a remarkable expansion in recent years, with the daily refining capacity increasing from 290,000 barrels in 1946 to 4,058,000 in 1960. Approximately 45 per cent of the refining industry is concentrated in France and the United Kingdom. Italy and West Germany combined have an additional 34 per cent, and small refining centers have developed in Belgium, the Netherlands, Sweden, Portugal, Spain, Austria, Czechoslovakia, Finland, Greece, Poland, Romania, and Yugoslavia.

The Middle East has a daily crude refining capacity of slightly over 1,450,000 barrels. This is approximately 7 per cent of the world's total. It is now estimated that Russia has a refining capacity of about 2,500,000 barrels daily. This is about 25 per cent of U. S. capacity. The refining industry of the Far East was partially destroyed during World War II and recovery was handicapped in the early postwar period by economic and internal disturbances. However, a major refinery-building program has been in effect since 1955. This region in 1960 had a daily refining capacity of about 1,229,000 barrels, of which 609,000 barrels were located in Japan.

UNITED STATES

Establishment of refinery pattern. The development of the oil refinery pattern in the United States has always reflected the availability of crude oil and markets. Almost simultaneously with the discovery of oil in the Appalachian Province in 1859, refineries were built in the oil region, in the important market centers of Cleveland and Pittsburgh, and in the Atlantic Coast cities of Philadelphia, Baltimore, and New York. Until 1890, four states—New York, New Jersey, Pennsylvania, and Ohio—processed more than 95 per cent of the crude oil. Within this region the East Coast refineries produced about 60 per cent of the total refined products. This concentration in refining can be attributed to the large eastern markets, a growing demand for refined products abroad, and the influence of the Standard Oil Company in developing refineries in market areas.

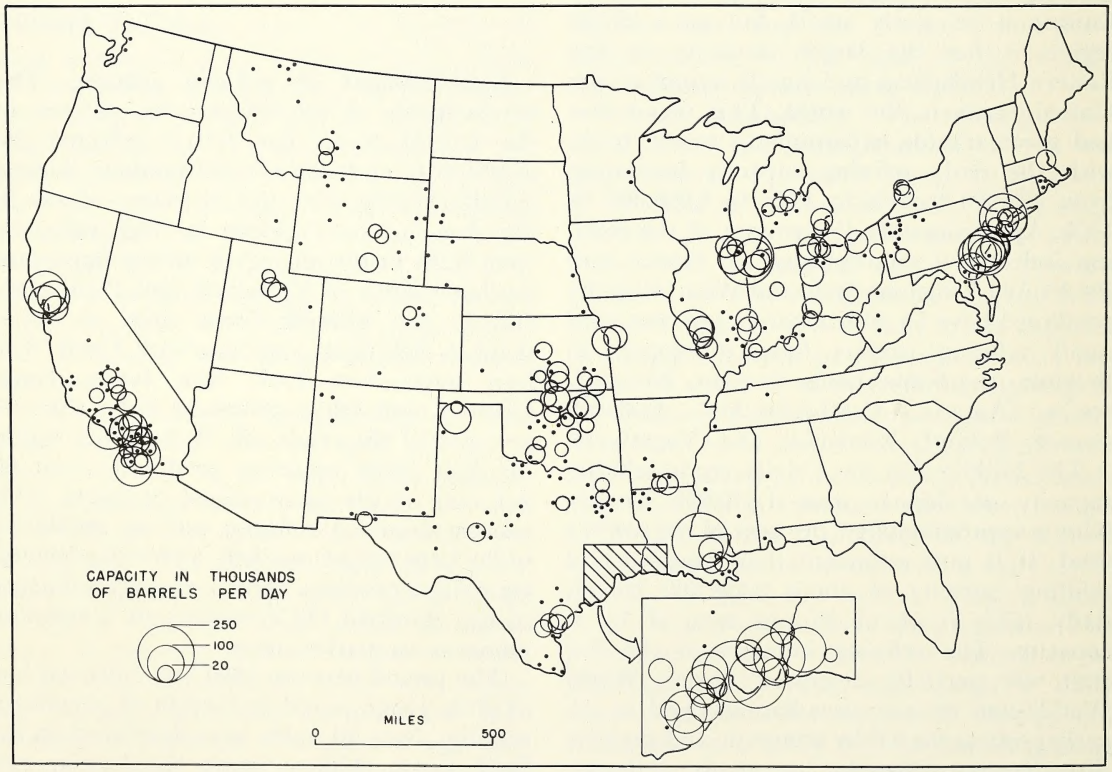
The period between 1890 and 1910 was one of great geographical expansion of petroleum refining. New oil fields were developed in the Gulf Coast, Midcontinent, California, and Illinois-Southwestern Indiana provinces. As a

consequence, dominance of the northeast in refining rapidly declined. Major new construction was concentrated first in the Chicago area, next along the Gulf Coast, then in the Midcontinent, and somewhat later in California. By 1910 the East Coast and Appalachian refineries were processing no more than 35 per cent of the nation's crude oil. Although the industry has increased greatly in size in recent decades, the basic refining pattern established before 1910 has changed but little (Map 13.2).

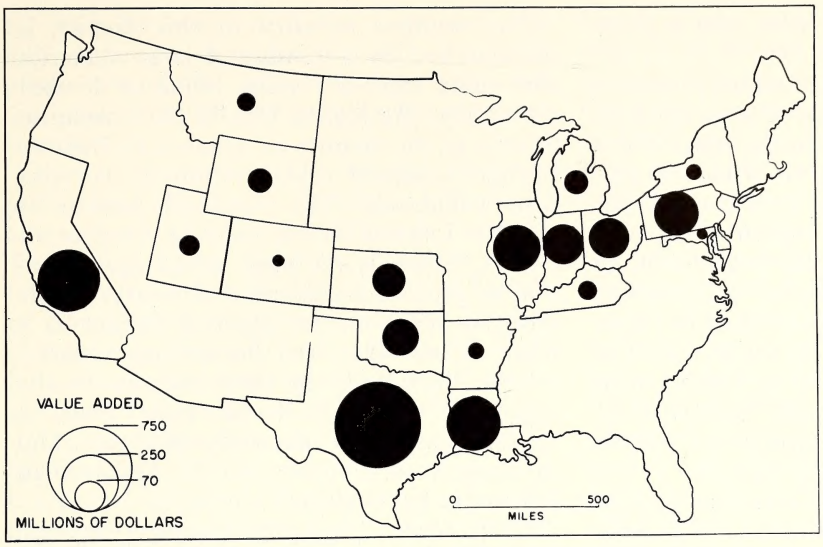
Petroleum refining districts

East Coast. The development of the refining industry on the East Coast is in response to the area's large market. Although this area has no local production, it possesses a refinery capacity of about 1,480,000 barrels per day. This is about 14 per cent of U. S. petroleum capacity. The Philadelphia area, with four refineries, is the largest center, with a daily capacity of nearly 700,000 barrels. New Jersey, with centers at Bayonne and Linden, is second in importance. Minor centers are located at Baltimore, New York, and Boston. The refineries in this district have expanded at a rapid rate since 1940. At the beginning of World War II this area was processing slightly over 200 million barrels annually. In 1960 the area processed about 400 million barrels of crude oil.

All refineries in this region are located on the coast to obtain domestic and foreign crude oils by water. In 1960 approximately 168 million barrels were from domestic fields and 235 million were imported from foreign sources. All of the foreign oil is transported to the area in tankers, and more than 95 per cent of the domestic supply is moved on interstate boats. Of the domestic oil brought by tankers, Texas is the leading supplier, followed by Louisiana and New Mexico. Venezuela is the principal source of foreign oil, but since 1945 Middle Eastern



13.2. United States—Petroleum Refining Capacity by Centers.



13.3. United States — Petroleum Refining—1958.

oil is also being imported. The East Coast is the principal area in which domestic crude oils come into direct competition with foreign petroleums.

Appalachian. Although the U. S. petroleum refining industry started in this district with the discovery of oil in 1859, it is no longer one of the important refining regions. The expansion of refining facilities in recent years is considerably below the national average. In 1960 there were 17 refineries, with a total daily capacity of 232,490 barrels. This region has a refining capacity only about 15 per cent as great as that of the East Coast District. Between 1940 and 1960 the number of refineries decreased from 39 to 17. The industry is characterized by small plants originally located in relation to an immediate supply of crude oil. There are also many companies working with limited capital and unable to expand operations in periods of great demand. This picture is more vivid when it is realized that the seven refineries which have the most favorable market positions refine 75 per cent of the crude oil, leaving only a relatively small supply of crude oil for the other refineries of the area.

This region, however, has one important advantage in maintaining a refining industry. The highest-grade paraffin-base oil in the world is produced in the Appalachian fields. Consequently, the refineries specialize in the production of lubricating oils. Knowledge of the trade mark "Pennsylvania Grade" has become world-wide.

Still, the future of the small refineries in the area is not bright. These refineries, such as those at Bradford, Warren, and Oil City are dependent upon the crude oil production of an oil region that has reached two "zeniths," once by ordinary producing methods and once through secondary recovery operations. Therefore, with slight hope of increasing the region's productivity for a third time, there is little incentive for the expenditure of capital investments in refineries that are localized by this declining crude oil source.

The region's larger refineries, with daily capacities of 10,000 barrels or more (such as those in the Pittsburgh, Buffalo, and Cleveland areas), will continue to grow. These refineries are becoming increasingly dependent on crude oil imported largely from the Midcontinent fields and are also situated in the most favorable market positions in the region.

Interior. The Interior District, with its dense population, great urban concentrations and large manufacturing centers, is one of the large oil refining regions. As in all areas with a large market, refining capacity has been rapidly expanding in recent years. In 1940 the region had 87 refineries and processed 225,847,000 barrels of crude oil. In 1960, although there were but 57 refineries in

operation, they processed over 500 million barrels of crude oil.

The two greatest factors in refinery location in this area are the influence of large markets, particularly in those cities on the lower Great Lakes, and the availability of crude oil supplies. The Chicago region, with over 60 per cent of Illinois' refining capacity and over 90 per cent of Indiana's is the largest refining center. The refineries located at Whiting, East Chicago, Wood River, and Hartford have a daily capacity of about 700,000 barrels. The second center of importance is Toledo, with a refinery capacity of 250,000 barrels daily. These two centers have approximately 80 per cent of the district's refining capacity.

Besides these major concentrations each of the petroleum producing districts in Illinois, Indiana, Ohio, Kentucky, and Michigan have oil refineries. These field refineries are generally small, and are declining in importance. The trend is to abandon operations when the plant becomes antiquated.

The oil fields within the district do not produce sufficient petroleum to supply refinery demands. In recent years the Illinois, Lima-Indiana, and Michigan provinces have been producing between 95 million and 105 million barrels annually, supplying about one-fifth of the area's refinery needs. The oil field refineries are essentially supplied by crude oil within the region. The market-oriented refineries, however, must import crude oils principally from the Midcontinent fields in Texas, Oklahoma, and Kansas. Because water transportation is lacking, more than 90 per cent of the crude oil is supplied to the refineries by pipelines.

Midcontinent. The refining industry of the Midcontinent District has developed as a result of the availability of huge reserves of crude oil. This is one of the larger oil producing regions in the world and is an important oil refining district. As production increased the facilities of this region have also grown. In 1940 the refineries processed 201,437,000 barrels of crude oil and in 1960 about 359,000,000 barrels. However, the refineries of the region process only about 40 per cent of the present production. This area is one of the largest suppliers in the United States of crude oil to eastern refinery districts.

The refinery industry in this district is characterized by a number of large refineries and many relatively small refineries located throughout the region. One of the concentrations is in the vicinity of Augusta-El Dorado, Kansas. A second concentration is at Ponca City, Oklahoma. The dispersed pattern of refinery location stems from a number of factors. There is no large urban agglomeration to provide a concentrated market in the area. In addition, the regional market as a whole is not large, and the refining capacity is thus distributed in close relation to the supply of crude petroleum. This district is an example of raw material orientation, and in many ways is similar to the Appalachian District in its locational aspects.

Gulf Coast. The Gulf Coast of Texas and Louisiana is now the largest refining district in the United States, with about 30 per cent of the total output (5). This area has had a remarkable growth, daily refining capacity having increased from 1,800,000 barrels in 1948 to over three million in 1960. Of the twelve largest refineries in the country six are on the Gulf Coast. The Texas Gulf Coast, with refining centers at Houston-Texas City, Beaumont-Port Arthur, and Corpus Christi, refined in 1960 640 million barrels out of the state total of 736 million barrels. Thus, this region has nearly 88 per cent of all Texas crude distillation output. The Texas Gulf Coast District derives about 85 per cent of its needs from within the state, 8 per cent from Louisiana, 4 per cent from New Mexico, and one per cent from Oklahoma. In Louisiana the major refining centers are at Baton Rouge and Lake Charles, with a secondary center at New Orleans.

The importance of the Gulf Coast lies in its tidewater position, with a major oil producing area located in its interior. The crude oil is transported from the interior by pipelines and, at tidewater, a significant portion is refined before the rest is sent by tanker to its markets. The market for Gulf Coast petroleum products is increased by its geographical location, which allows the transportation of its products by water to the East Coast, up the Mississippi River system to the Midwest, and to overseas markets. There is also a fairly large market within the region.

In 1959 the state of Texas consumed 105 million barrels of motor fuel out of a total production of 280 million barrels. This still left more than 60 per cent to be marketed elsewhere.

Rocky Mountains. The refining industry of the Rocky Mountain District is still small, although it is growing as production increases. The oil refining capacity increased from 169,000 barrels daily in 1945 to 350,000 barrels in 1960. During the same period the number of refineries declined from 103 to 32. This indicates the disappearance of pool refineries and the development of field refineries.

The refineries of the region are raw material oriented and refinery demand for crude oil is supplied entirely within the region. In 1960 the area produced over 250 million barrels of crude oil derived largely from New Mexico, Wyoming, Colorado, and Montana. The Rocky Mountain District processed about 20 per cent of this amount, and the remainder was sent by pipelines primarily to the Midcontinent and Gulf Coast refineries.

The lack of water transportation for both crude oil and refined products, the small regional market, and the inaccessibility of this district to the large eastern markets for refined products have been handicaps to an early and significant development of the industry.

California. The refining industry of the California District, the fourth largest in the United States, has expanded in recent years. The capacity of the refineries has increased from a 1,103,400-barrel daily capacity in 1948 to 1,550,000 barrels in 1960. With California's large petroleum production and its geographical separation from oil activities in other states, its refineries are primarily supplied from state production. Because of declining oil reserves a pipeline now connects the California refineries with the Midcontinent oil fields.

The California refining industry shows a remarkable concentration in two counties. Los Angeles County has a petroleum refining capacity of about 800,000 barrels daily, with twenty-seven refineries. The more important refining centers are Torrance, Long Beach, El Segundo, Signal Hill, Venice, and Wilmington. The second county of importance is Contra Costa, with four refineries having a capacity of 300,000 barrels daily. The refining industry is increasingly being concentrated in these two counties. Many of the refineries in other areas are being abandoned. Between 1940 and 1960 the number of refineries in California decreased from 82 to 38. Although this was a decline in number of refineries, the refining capacity of the area increased in the same period by over 400,000 barrels daily.

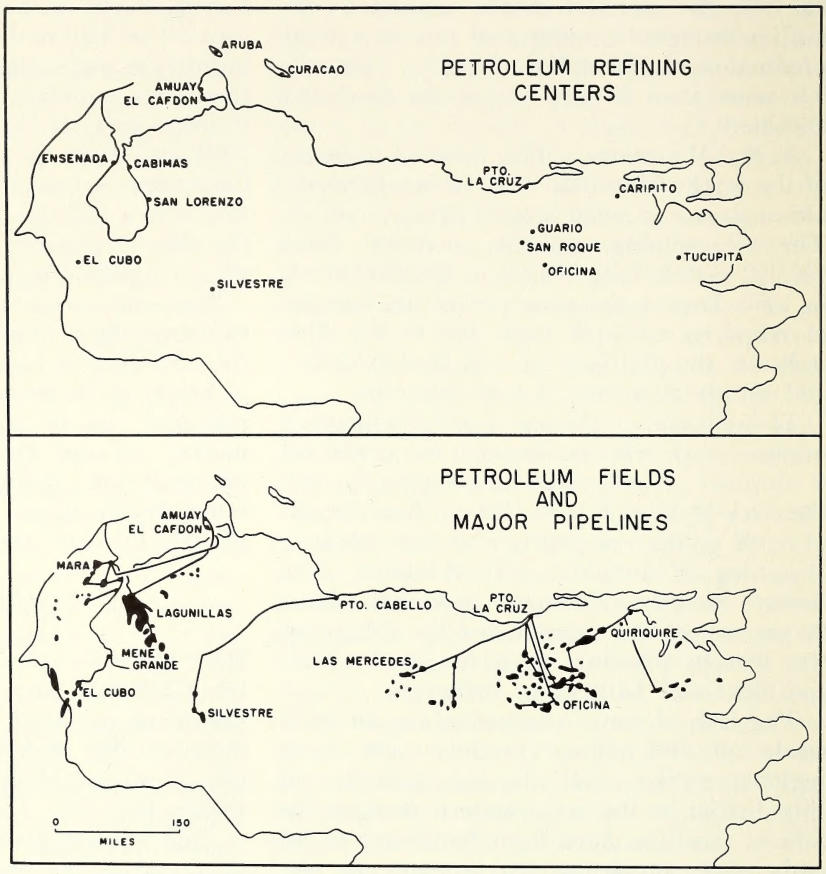
This concentration of refining capacity is explained by a number of factors. Foremost, the refineries are located in respect to supplies of crude oil from nearby fields. Second, the refineries are in the midst of the largest market on the Pacific Coast. Finally, the refineries are situated near the ocean, and other Pacific Coast markets are thus easily reached by water transportation.

CARIBBEAN AREA

Since the early years of the twentieth century the Caribbean area has been an important petroleum producer. Until the rapid development of the Middle East oil industry the greater amount of oil in world trade originated in this area.

About 38 per cent of the refining industry of this important region is located on the two small Netherlands West Indies islands of Aruba and Curaçao about 40 miles off the northern coast of Venezuela. Although neither of these islands has any oil production, the crude oil is obtained from nearby Venezuela. Venezuela, with a production of 1,041,000,000 barrels in 1960, is the third largest oil producing country in the world, but her refining industry is capable of processing less than 20 per cent of this production.

When a subsidiary of the Royal Dutch Petroleum Company developed the first large oil field in Venezuela in 1917, the present company chose the adjacent island of Curaçao, a Dutch colonial possession, as the site for its refinery (Map 13.4). Likewise, in 1928, when the Standard Oil Company of New Jersey sought a refinery site in the Caribbean, the Netherlands government made it attractive for them to locate on the nearby island of Aruba. The selection of refinery sites outside Venezuela was encouraged by a number of



13.4. Venezuela — Producing and Refining Centers.

factors. The Netherlands government welcomed the industry as a source of income for its West Indian colonies. During the early period of petroleum development a relatively unstable Venezuelan government did not encourage major investments by foreign companies. The early oil fields were located in the Maracaibo Basin, which was inaccessible to large ocean-going tankers, and pipeline facilities had not developed, the oil being transported out of the basin on small barges. The barges were capable of carrying the oil to the Dutch islands as easily as to a coastal position in Venezuela. Finally, there was the advantage for Curaçao and Aruba of being at the "crossroads" of the Caribbean Sea. They have thus been in an excellent position to market the refined petroleum products to the world.

The refineries on these islands are among the world's largest. Although the Standard Oil refinery on Aruba has a daily capacity of 440,000 barrels and the Royal Dutch refinery on Curaçao a daily capacity of 210,000 barrels, they are capable of processing only about 25 per cent of Venezuelan production. The refineries are operating at near capacity, but no additions are contemplated. Because of the efforts of the Venezuelan government to increase the amount of Venezuelan crude oil refined domestically, the future of the refineries on Aruba and Curaçao is uncertain. In recent years employment in the refining industry of the islands has declined, primarily from increased automation. Because the economic life of these islands is dependent on the petroleum refining industry, the possibility of a declining crude oil supply is a matter of concern to the Dutch government.

A complete range of products is made at each refinery. There are, however, some special problems in locating refineries on these islands.

They lie within the Trade Wind belt and are practically without fresh water. Unlike mainland operations where water is normally available, about 5,000 barrels of water had to be imported each day for refinery operations alone on Aruba until a unit was installed for the evaporation of sea water. Because the islands have little agricultural land, nearly all food must be imported. Most of this food comes from the United States, transported on specially refrigerated vessels. The oil refining industry has created completely new settlements on these Caribbean islands.

The Venezuelan refining industry has experienced a remarkable growth, with capacity increasing from 116,000 barrels daily in 1948 to 936,000 barrels in 1960. Venezuela has over 50 per cent of the Caribbean area's refinery capacity. The growth of the refinery industry in Venezuela has been primarily in response to government legislation. At present all oil companies are required to refine one-tenth of their production within Venezuela. The expansion of the refinery industry has also been encouraged by the granting of exemptions from import duties on refinery construction materials and on crude oil imported for refining.

Because the consumption of petroleum products in Venezuela is only about 150,000 barrels per day, the refineries are oriented to the export market. The two largest refining centers, with about 80 per cent of the nation's capacity, are at Amuay and Cafdon on the north coast. Other smaller coastal refining centers include Puerto La Cruz, Cabimas, Ensenada, and San Lorenzo. Small refining centers are oriented to the oil producing fields, such as Guario, San Roque, Oficina, Caripito, and Tucupita in eastern Venezuela.

Colombia and Trinidad are small petroleum refining centers in the Caribbean area. Trinidad possesses three refineries at Pointe-a-Pierre, Point Fortin, and Brighton with a total capacity of about 200,000 barrels per day. Over 80 per cent of the petroleum processed is exported. The five Colombian refineries have a combined crude oil capacity of 71,400 barrels per day. The principal center is at Barrancabermeja in central Colombia. This refinery is oriented to nearby crude sources and serves a regional market. The second petroleum refining center of Colombia is at Cartagena. This refinery secures most of its crude oil by pipeline from central Colombia, and supplies not only the northern Colombian market, but also that of its western coast by tanker through the Panama Canal.

WESTERN EUROPE

Western Europe is one of the major petroleum consuming areas in the world, but it has little oil production (7). In order to gain a degree of self-sufficiency most countries have constructed oil refineries within their borders. Because the development of the refining industry in France and West Germany illustrates the general policies of many of the western European nations, these countries have been selected for more detailed analysis (15).

France. France, although having an extremely small domestic oil production, has developed one of the largest oil refining industries in Europe. The Péchelbronn field of eastern France and the Parentis field in southwestern France produce less than 6 per cent of French requirements (22). The importance of petroleum was demonstrated to France in World War I, and in the early 1920's she established a petroleum policy designed primarily to expand her refining industry. This policy was based on three points: first, the economic control of a foreign source of crude oil to supply a large part of domestic refining requirements; second, the development of a French tanker fleet to transport the crude oil; and third, the construction of a domestic oil refining industry.

As the first step toward the completion of this policy, France secured control of 23.75 per cent of the stock of the company developing the Iraq oil fields. Due to the expanding market, France purchased not only her share but also the greater part of the output set aside for other shareholders in the Iraq venture. Thus, in a typical prewar year (1938) when France had total imports of approximately 50 million barrels of crude oil, 22 million barrels came from Iraq. During this period, the French oil tanker fleet developed rapidly, in 1939 reaching the imposing figure of 516,000 gross tons. About 40 per cent of

France's crude oil requirements were transported in French vessels.

The French refineries were strategically located on the French coast in order to secure foreign imports and also serve the area lying immediately to their hinterland. In 1939 France had 15 refineries: five on the English Channel, four on the Mediterranean, four on the Atlantic Coast, and only two inland. The most important coastal refining centers were Marseilles, Frontignan, Bordeaux, St. Nazaire, Le Havre, and Dunkerque. The only large refining center not on the coast was in Paris, where crude oil was received by pipeline and barge from Le Havre.

During World War II the French refining industry was badly damaged. Between the demolition ordered by the French government and the bombing by the Allies, 12 of the plants were practically destroyed. Only two of the three plants near Marseilles escaped any serious damage. With the cessation of hostilities the repairing and construction of new plants began immediately. Because coal has been scarce and expensive in the postwar period, France has turned increasingly to petroleum to supply her energy requirements. A comparison of fuel oil and bituminous coal costs in 1949 in France showed that the former was 45 per cent cheaper than imported German or American coal. As a consequence, French economic planners have developed a comprehensive program for extending the use of liquid fuel, particularly to the manufacture of iron and steel, glass and ceramics, electric power production, and the operation of diesel engines.

The French refinery industry remains concentrated in coastal cities. This position reflects not only the need for serving regional market areas in France but also accessibility to foreign sources of crude oil. Until recently France imported most of its crude petroleum from the Middle East and Venezuela, but with the growing exploitation in the Sahara region of north Africa this area has become increasingly important as a source. In 1960 there were 14 refineries in France, with a total crude oil capacity of 831,700 barrels per day. Planned expansion will raise the daily capacity to 930,000 barrels by 1965. The major refinery centers of France are Le Havre (Port Jérôme), Marseilles, Dunkerque, Bordeaux, Gonfreville, Le Petit-Couronne, L'Avera, Frontignan, Pauillac, Donges, and Bec d'Ambes.

In the past, Paris has been the only interior center with a significant refinery industry. However, with the growing demand for petroleum products in the Rhine region because of its dense population and concentration of heavy industry, the French government has approved the erection of two refineries in the Strasbourg area. The planned crude pipeline from Marseilles to middle Europe will have its terminals at Strasbourg in France and Karlsruhe in West Germany. As a result, Strasbourg and Karlsruhe will eventually become two of Europe's largest inland oil refining centers.

West Germany. Germany had developed only a small crude oil refining capacity by 1939. Most of the country's petroleum demands were met by imports of finished and semifinished products and by the output of the country's 27 hydrogenation and synthetic gasoline plants, using coal as a raw material. Thus, of Germany's 18 oil refineries at the beginning of World War II only two processed crude oil. The others were based on the processing of imported petroleum products.

During World War II most of the petroleum refineries were heavily damaged. At the end of the war synthetic gasoline production was outlawed by the Allies for the first five postwar years, and domestic coal could thus no longer be used to make petroleum products. During the same period the importation of finished and semifinished petroleum was greatly reduced, since this required a considerably higher outlay of foreign currency than the importation of crude oil. The policy was thus initiated to create a petroleum refining industry for processing imported crude oil in Germany.

The first step to implement this policy entailed the rebuilding of prewar crude oil refineries which had been reduced by military action from the former capacity of 15 million barrels to a capacity of seven million barrels. The first refinery to be rebuilt was the Esso plant in Hamburg, which went into operation in 1947. In 1948, the hydrogenation works at Gelsenkirchen and Wesseling were reopened,

using petroleum instead of coal as raw material. Initially they produced only gasoline, but later were expanded into full-scale oil refineries. In 1949, the British Petroleum, Shell, and Socony Mobil plants were built in Hamburg. During this early period of redevelopment, a number of German-owned refineries were built, operating primarily on domestic crude oil.

By 1950 the initial refinery program was completed. At this time the petroleum refinery capacity was about 22 million barrels annually, only slightly below the country's total consumption of oil products. In order to supply the nation's demands, shale oil, coal-based benzol, and imported oils were utilized. By 1953 the petroleum refinery industry could supply most of the West German oil requirements and the shale oil and coal plants were abandoned. Nevertheless, a certain quantity of finished products continues to be imported. The main import item is fuel oil, since the demand for this product has been growing so rapidly that German refineries have not been able to satisfy the domestic requirements. In 1952 fuel oil accounted for only 8.5 per cent of total consumption; however, by 1960 it had risen to over 40 per cent, making it the most important petroleum product.

As the market for petroleum products continues to rise in West Germany, the refinery capacity has also been expanded. In 1961 the industry had a capacity to process about 800,000 barrels per day. The domestic oil production has not been able to keep pace with refinery demands. The oil processed in Hamburg, Bremen, and the Rhine-Ruhr refineries is largely supplied from foreign sources. In 1960 over 80 million barrels of crude oil were imported from the Middle East and about 35 million barrels from Venezuela. Domestic production supplied about 33 million barrels. The Schleswig-Holstein, Emsland, Hanover, and Baden refineries are largely supplied with domestic crude oil.

Since 1950 a number of changes in the localization of the petroleum refinery industry have occurred. The most important change in the distributional pattern is the shift of the industry's center from Hamburg to the Rhine-Ruhr area. There are several reasons for this change. First, the coal hydrogenation and synthetic oil plants in the Ruhr were converted to crude oil refineries for economic and political reasons. Second, Hamburg lost a large portion of its market area with the partition of Germany. Hamburg became a port on the periphery of the country, while the Ruhr was better situated to supply the refined products needed by the nation. Third, with the rapid growth of fuel oil consumption, the Ruhr emerged as the major consuming area. Finally, because Hamburg and Bremen are inland ports there has been difficulty in developing dock facilities for the modern supertankers. In 1951 the Hamburg and the Rhine-Ruhr area were about equal in refinery capacity. By 1960 the refinery capacity in the Rhine-Ruhr area was about double that of Hamburg. The Rhine-Ruhr area now possesses more than 50 per cent of West Germany's refinery capacity. The Hamburg region possesses about one-third of the nation's capacity. Other refinery centers include Bremen, Hanover, Schleswig-Holstein, and Emsland, each with about 5 per cent of the total capacity.

MIDDLE EAST

Within the past decade the Middle East has emerged as one of the greatest oil producing regions in the world (Map 13.5). Oil production has increased from 2,800,000 barrels daily in 1940 to about 5,250,000 barrels in 1960. Although there is only a small market for petroleum products within the area a large refining industry has developed to process the crude for a world market. In 1960 there were 15 refineries in the region with a total daily capacity of 1,350,000 barrels. This compares with a total daily capacity of 940,000 barrels in 1950. The present refineries are capable of processing about one-quarter of the region's crude oil production.

Nearly 90 per cent of the refinery capacity of the Middle East is located on the Persian Gulf, for several reasons. The petroleum fields of the Middle East, with the exception of Kirkuk, lie within easy reach of the Persian Gulf. As a result, the major share of the petroleum produced flows to this region. The pipeline systems of Iran, Kuwait, the Neutral Zone (between Kuwait and Saudi Arabia), Saudi Arabia, and Bahrein terminate on the Persian



13.5. Middle East—Producing and Refining Centers.

Gulf. The local demand for refined products is highly limited. Consequently, the larger refineries are coastal in position indicating their orientation toward foreign markets. The refineries are situated at the break-in-bulk point in order to have the advantage of low-cost water transportation in marketing their finished products.

The refinery at Abadan, Iran was the first to be established in the Middle East. Plans for its construction were conceived in 1909 when the Anglo-Persian Oil Company, Ltd. procured a building site on Abadan Island, halfway between Basra and the Persian Gulf. Since 1913, when the refinery went into operation it has been in a constant state of growth. The Abadan refinery is the largest in the Middle East, with a capacity of about 514,000 barrels daily.

The location of the major oil refinery centers of Iran at Abadan was favored by a number of considerations. There was level, uninhabited land available for coastal refining operations and future expansion. The oil fields of southern Iran are nearby. The dock facilities at Bandar Mashur are capable of handling the largest tankers. Water for cooling purposes was readily available from the Shatt-al-Arab, formed by the union of the Euphrates and the Tigris rivers. Finally, the tidewater location facilitated the marketing of petroleum products in foreign areas.

Besides the Abadan refinery, four other refining centers have developed on the Persian Gulf at Bahrein on Bahrein Island, Ras Tanura in Arabia, Mina-al-Ahmadi in Kuwait, and at Mina Saud and Mina Abdullah in the Neutral Zone. The oil industry of Bahrein Island and Saudi Arabia is controlled by American interests. The Bahrein refinery, built in 1936 with a 10,000-barrel daily capacity, has been enlarged to a 210,000-barrel daily capacity in 1960. The refinery was originally constructed because of the difficulty the Bahrein Petroleum Company had in finding markets for its crude oil. Most of its markets lie in South Asia where refinery capacity was lacking. In recent years the market area has been enlarged. The crude oil for the refinery comes from the fields of the Bahrein Island and by pipeline from the nearby oil fields of Saudi Arabia.

The Ras Tanura refinery, designed in 1943 as a war project, began production in 1945, and in 1960 had a capacity of 260,000 barrels daily. The refinery was located at Ras Tanura because of the availability of a deepwater harbor. The crude oil comes entirely from Saudi Arabia and is transported by pipeline to the refinery. The refinery was constructed in desert country so that a completely new settlement has developed. Because there is little local market for petroleum products in this area, nearly all crude and refined petroleum is exported, principally to Western Europe and North America. It is not likely that refinery expansion will be maintained at the same rate as field development.

The refinery at Mina-al-Ahmadi in Kuwait had a capacity of 190,000 barrels daily in 1960. This refinery was constructed for the express purpose of supplying fuel for vessels calling at the Mina-al-Ahmadi dock and to satisfy the local demand for petroleum products. The refinery produces mostly diesel and fuel oils. The two refineries at Mina Saud and Mina Abdullah, with a daily capacity of 50,000 and 30,000 barrels respectively, were completed in 1958. They are the newest refineries in the Persian Gulf area.

Three refineries are located on the Mediterranean Coast at Haifa, Israel and at Sidon and Tripoli in Lebanon. The Haifa refinery, established in 1939, with a daily capacity of 87,000 barrels, was developed by the British primarily to supply their navy in the eastern Mediterranean and for export of refined products to European countries. The refinery originally secured its crude oil from Iraq, by the southern leg of the 12-inch Mediterranean pipeline system. However, since 1948, as a result of the Arab-Israeli dispute, no oil from Arab countries is available to Israel. Consequently the refinery has operated at 6 to 30 per cent capacity. In recent years the Israeli government has purchased crude oil from the National Iranian Oil Company and from Venezuela. The Iranian Oil Company crude oil reaches the refinery by pipeline from Aqaba.

The Lebanese refineries are much smaller in size than the Haifa plant, having a combined daily capacity of 23,000 barrels. The oil for these refineries comes from the Middle East fields, with Iraq supplying about 80 per cent of the total. The remainder comes from Saudi Arabia and Bahrein. These refineries have been constructed for the purpose of supplying the local market with refined products. The refinery at Tripoli was built at the terminus of the Iraq Petroleum Company's 12-inch pipeline from Kirkuk. The Sidon refinery, completed in 1955, is one of the projects designed to meet Lebanon's plan for industrial development and the increasing demands of its highway transportation system.

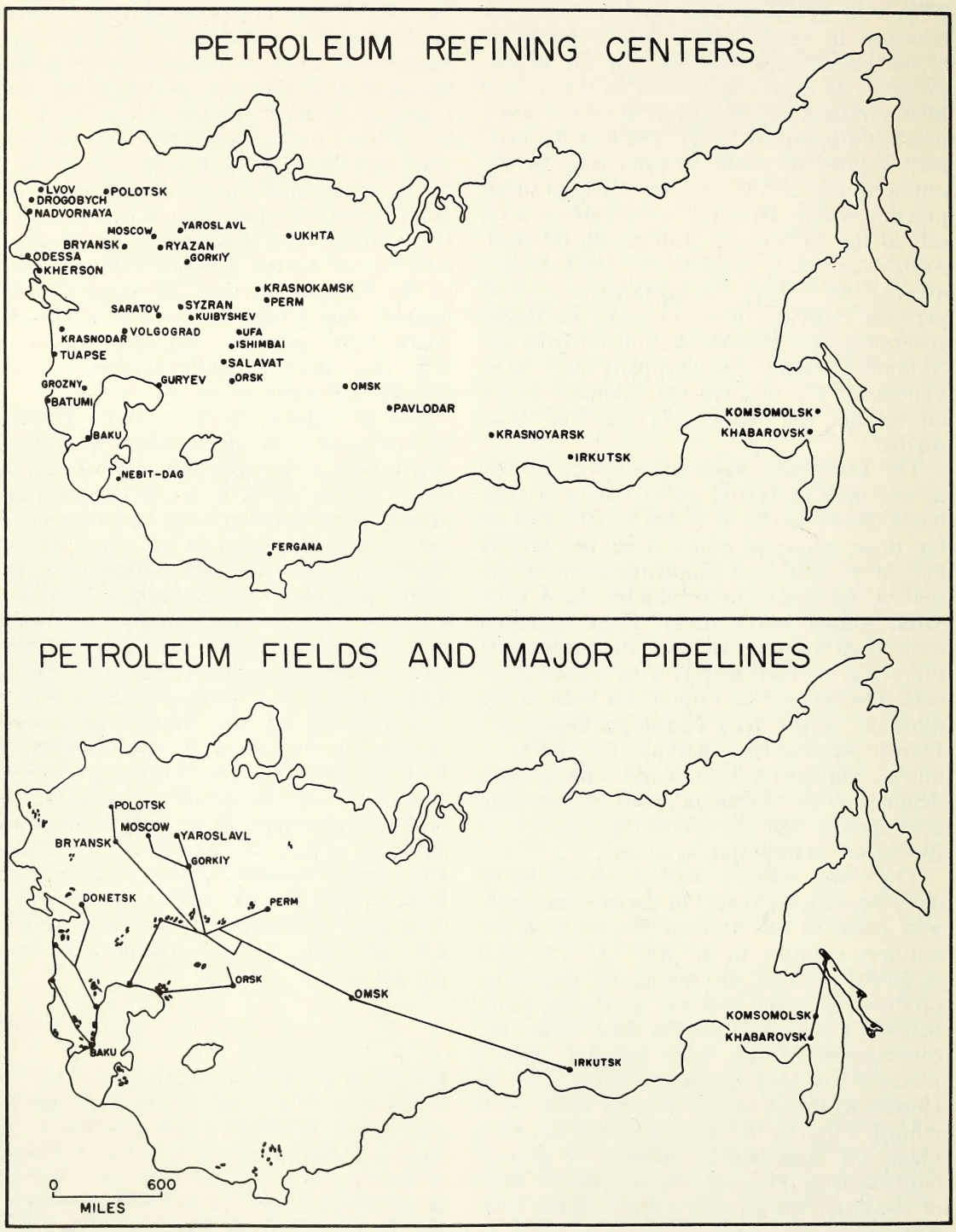
The Aden refinery, with a 100,000-barrel daily capacity, is situated in the extreme southwest point of the Arabian Peninsula at the southern entrance to the Red Sea. The port is ideally located for marketing petroleum products. It is the half-way bunkering point between Europe and the Far East. Before the construction of the Aden refinery, refined products had been shipped to Aden from the United Kingdom, where Persian Gulf oil is refined. Thus, by the construction of the Aden plant, this uneconomic backhaul of Persian Gulf oil from England was eliminated. Most of the crude oil for this refinery comes from Kuwait.

The refineries in the interior of the Middle East are located at Kermanshah in Iran and at Khanaqin (Alwand), Kirkuk, Mosul, and Baghdad in Iraq. The internally located petroleum processing plants are oriented to local markets and a nearby source of crude oil. The largest of these refineries is at Baghdad, with a capacity of 48,000 barrels daily. This is the first refinery in the Middle East that has been built with Arab funds, having been financed by the Iraqi government's Oil Refining Administration. The refinery is designed to serve Iraq's internal petroleum needs. The Baghdad refinery was erected because of the proximity to the Baghdad market (the largest in the nation), the transportation offered by the Tigris River, and the availability of water from this river for cooling purposes in the refinery operations.

The oil industry is still in its initial stage of development in the Middle East. Production is increasing rapidly and reserves are the largest in the world. It can be expected that present refining centers will be enlarged and new centers developed as new oil fields are discovered and exploited. Nevertheless, two factors may retard future growth. Because of unstable political conditions in the Middle East companies may be unwilling to invest large amounts of capital in expensive refining operations for fear of expropriation, such as that initiated by the Iranian government against the Anglo-Iranian Oil Company in 1951. In that year the Iranian government nationalized the oil industry. The market for Middle East crude oil in foreign areas also mitigates against the growth of the Middle East refinery industry. At present, Europe, the Middle East's primary market, is intent upon developing a self-sufficient petroleum refining industry. Thus, Europe's demand is for crude oil, not refined products.

SOVIET UNION

Petroleum production began in the U.S.S.R. in the early 1860's, and the Soviet Union has continually maintained her position as the second or third largest producer in the world. A striking feature of the petroleum industry in the Soviet Union has been its phenomenal rise in output, from 266,200,000 barrels in 1950 to 1,075,000,000 barrels in 1960. In the



13.6. Soviet Union—Producing and Refining Centers.

latter year her output was exceeded only by that of the United States.

From the first days of oil refining Russia has possessed a domestic refinery industry. Prior to 1950 the refining industry was limited in its distribution (14). The major centers were localized on the oil fields of Baku, Maikop, and Grozny in the Caucasus area. The oil products of these refinery centers were marketed primarily by barge on the Caspian-Volga water route to the consuming centers of western Russia. During this same period crude oil moved westward from the Caucasus area to the Black Sea coast. In the eastern Black Sea area refineries developed at Tuapse and Batum. Some of the crude oil was also shipped across the Black Sea to refineries in Odessa and Kherson. These refineries on the Black Sea, supplying the markets of southern Russia, are at points where oil is transferred from ship to land transportation, or land transportation to ship.

In the years immediately prior to World War II, the Volga-Urals area came under petroleum exploitation. The processing of oil was initiated in this region with refineries at Guryev, Saratov, Syzran, Kuybyshev, Krasnokamsk, and Orsk. Small refineries were also developed at Ukhta, Lvov, Drogobych, and Nadvornaya oriented to local oil fields. A refining industry also developed in Moscow, illustrating the influence of a market in the largest consuming center of the Soviet Union.

Since World War II a number of changes have occurred in the distribution of the Soviet refining industry (Map 13.6). The most significant of these has been the orientation of the refinery industry to consuming areas. A refinery concentration has developed in the Central Industrial District, including Moscow, Yaroslavl, Gorkiy, Ryazan, Bryansk, and Polotsk. New refinery centers have also been built in Western Siberia at Omsk, Pavlodar, Krasnoyarsk, and Irkutsk. In the Far East, oil refineries have been built at Komsomolsk and Khabarovsk, supplied principally by Sakhalin crude oil. These refineries are oriented to the regional markets. The seven-year plan (1959-1965) provides for the construction of oil refineries in practically all major consuming areas.

Oil refineries are still oriented to the oil regions of the Volga-Urals and the Caucasus. However, the importance of these regions is gradually changing. As a result of the absolute decline of oil production in the Caucasus, a surplus of refining capacity exists there, whereas in the prolific new area of the Volga-Urals fields, production has exceeded refinery capacity. Consequently, new refineries oriented to petroleum sources will be built primarily in the Volga-Urals area. At present, some crude oil flows from the Volga-Urals area to Baku for refining.

With the shift of the crude petroleum production center to the Volga-Urals region, a radical change in the flow pattern of oil has necessitated a change in the mode of transportation. The Caspian-Volga water route has declined in importance as a carrier of petroleum products. The movement of oil by pipeline from the Volga-Urals area is increasing in importance. This reflects the geographical expansion of the market areas.

The number of oil refineries has increased from 27 in 1951 with a daily capacity of 780,000 barrels to over 70 refineries in 1961 with a daily capacity of more than 2,600,000 barrels. The seven-year plan proposes that refinery construction will be maintained at a faster growth rate than crude oil output. It is planned that by 1965 the daily refinery capacity of the Soviet Union will be 4,548,000 barrels, and by 1972 at least six million barrels daily. The new refineries will be located in the main producing and consuming centers, and close to projected petrochemical plants.

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CHAPTER FOURTEEN

PORTLAND CEMENT INDUSTRY

In our industrial age portland cement is the most widely used nonmetallic construction material. Without today's improved concrete, modern methods of construction would be impossible. Cement has made possible the economical building and maintenance of more than two million miles of concrete highways in the United States. Concrete runways support heavy planes for commercial and military use, and concrete buildings and homes are found in every city and village. Its less spectacular uses are found on every farm in silos, fences, walks, pools, and household accessories. Concrete's hydraulic quality—the ability to harden under water—has made it the basic material in constructing bridges, dams, reservoirs, hydroelectric power works, and docks. Concrete is used not only for utilitarian purposes but is employed in structures of architectural beauty such as the Bahai Temple at Wilmette, Illinois.

HISTORICAL DEVELOPMENT OF THE INDUSTRY

The history of cement can be traced to the days of Babylonia and Assyria. The Egyptians used clay mortar in the pyramids and the Romans produced a type of cement by mixing volcanic ash with quicklime which, to this day, is often entirely free from fissures. Whenever mankind has undertaken to build with any degree of permanence and using rock, stone, or brick, it has been found that some form of cement is an indispensable construction material.

Before the development of portland cement the principal cements were natural cements and puzzolan. Natural cement is made from cement rock, a naturally occurring limestone that needs only to be burned and pulverized. Puzzolan cement is a mixture of slaked lime and granulated blast furnace slag. Since

these cements today constitute less than 1 per cent of the total output, this discussion will be limited to the production of portland cement.

A patent for the making of portland cement was first secured by Joseph Aspdin, a bricklayer of Leeds, England in 1824. This cement was called portland cement because when it hardened it produced a yellowish gray mass resembling in appearance the stone from the famous quarry of Portland, England. The new cement did not receive a ready acceptance because of the established reputation of the natural cements. It was not until the 1850's that portland cement gained a wide market in England, and by the 1860's the industry had developed on the European continent, particularly in Belgium, Germany, and France. The industry was well established in Europe before the first patent to produce portland cement was granted in 1872 in the United States.

MANUFACTURING PROCESSES

Portland cement is produced by burning a finely ground artificial mixture containing approximately 60 to 65 per cent lime, 20 to 25 per cent silica and 5 to 12 per cent alumina. The burning takes place at a high temperature and must therefore be carried on in kilns of special design and lining. The rotary kiln is most widely used and the raw materials, either in the form of a dry powder or a slurry containing from 30 to 50 per cent water, is fed into the upper end of the kiln. During the process of burning, the intense heat calcines the materials uniting them into a new chemical product, portland cement, in clinker form. The clinker must be finely ground as the final step in producing the finished product.

When cement is mixed with gravel, slag, or sand, plus water, and allowed to harden, the resulting artificial stone is concrete. The facility with which concrete in a semiliquid or plastic state may be molded or shaped into any desired form, and its capability of hardening, even under water, to an enduring, stonelike material, are exceedingly valuable properties for the construction industries.

LOCATIONAL FACTORS

Cement is a cheap, heavy commodity, manufactured from bulky raw materials and using considerable fuel. It can be produced profitably only on a fairly large scale. Consequently, the ideal location for a cement plant is one where supplies of raw materials and fuel are found in close proximity to each other and to a large market. Thus, ideally, the sites of plants are raw material oriented and the regional location of plants is market oriented.

Raw materials. The cement industry is one of the largest consumers of bulk raw materials. When a high calcium limestone plus clay or shale mixture is used, about 225 tons of limestone, 75 tons of clay or shale, 60 tons of coal, and five tons of gypsum are needed to produce 1,000 barrels of cement weighing 376 pounds each. Thus, nearly two tons of raw materials and fuel must be assembled to produce one ton of cement.

The types of raw materials used depend on the geographic location of the plant. In the United States in 1900, when the industry was predominantly centered in eastern Pennsylvania, cement rock constituted over 70 per cent of the raw material, while limestone and clay or shale was but 12 per cent and mud and clay but 18 per cent of the raw materials consumed. As the demand for cement increased and new plants were built in other sections of the country the excellent cement rocks of eastern Pennsylvania were not available and local raw materials were utilized. As a result the use of cement rock decreased from 70 per cent of the total in 1908 to about 25 per cent at present. There has been a corresponding increase in the use of limestone and clay or shale from 35 per cent in 1906 to nearly 70 per cent of the total in 1930. This figure has remained almost the same since 1930. In recent years marl and clay, and blast furnace slag and limestone have been minor sources of raw materials.

Of the raw materials, limestone exerts the greatest influence on cement plant location. Clay or shale is usually available in most localities, and even if they are not available locally, only about one-third as much clay or shale as limestone is needed. Coal normally moves toward the limestone because much

less coal is needed than limestone, and coal deposits are more geographically restricted. Although deposits of limestone are widely distributed not all are suitable for cement manufacture. A cement limestone cannot contain more than about 10 per cent magnesium carbonate, or improper ratios of aluminum, silica and iron oxide, or excessive impurities such as silica, iron pyrite or sulphur. Other factors to be considered in regard to limestone are the size of the deposits (to assure several years of operation), the method of mining that can be employed, and, especially, the location of the deposit in relation to convenient transportation lines and the cement market.

Energy requirements. Cement is produced by heating the raw materials in a rotary kiln to sustained temperatures of between 2,400° and 3,000°F. This is by far the principal energy needed in cement manufacture, and is at present satisfied through the burning of coal, natural gas, or fuel oil. The availability of a fuel determines what type is used. For example, in California fuel oil is used almost exclusively, while in Pennsylvania, coal is the principal fuel. In the United States in recent years coal supplied between 55 and 60 per cent of the energy used in kilns, oil 7 to 8 per cent, and natural gas 7 to 8 per cent. A combination fuel of coal, oil, and natural gas supplied about 30 per cent of the needs.

The amount of fuel required for processing purposes varies widely depending on the efficiency of the kiln. A representative figure is about 120 pounds of coal per barrel of cement, although kilns with the highest thermal efficiency require considerably less. Reasonable estimates hold that coal consumption in modern, efficient plants may soon fall to about 60 pounds per barrel.

The use of electrical energy is also an important factor in cement production. Electric power, needed in cement manufacture chiefly for grinding, averages about 20 kilowatt-hours per barrel. Since 1950 between two billion and 2,500,000,000 kilowatt-hours of electricity have been consumed annually in the U.S. cement industry.

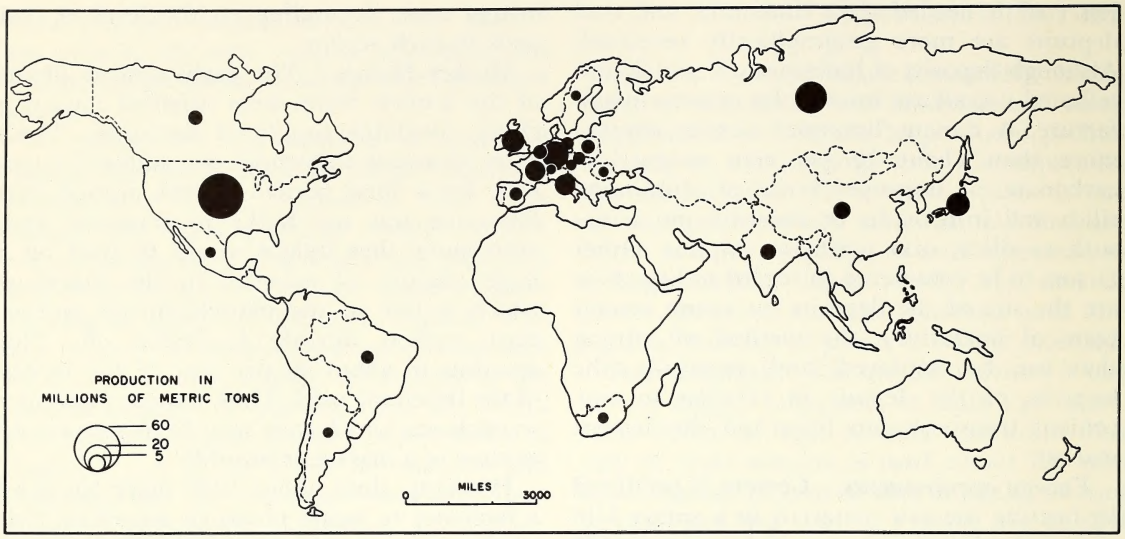
Since the economics of production favors plant location close to markets, it is evident that cement mills will have widely differing energy costs, depending on the level of fuel costs in each region.

Market factors. The early cement plants of the United States were oriented toward a cheap, available supply of limestone. These early locations influenced the industry's pattern for a long period. It was argued that limestone was too bulky to transport and, even more, that freight would be paid on a large amount of material in the limestone which is lost in the manufacturing process, since carbon dioxide is driven off. This amounts to about 40 per cent of the weight of the limestone used. Thus, cement plant sites were chosen which were near to limestone and as close to a market as possible.

However, since about 1920 there has been a tendency to locate plants in regard to their market areas, with the availability of raw materials playing a relatively secondary role. Many large plants are now constructed on the outskirts of cities. This has been especially desirable where navigable waterways give cheap transportation to distant raw materials. The large urban area not only provides a market for cement, but a convenient assembly point for raw materials. Coal may be obtained as cheaply or more cheaply than at a limestone quarry, and clay or shale is usually found in the immediate vicinity. Although freight is paid on the waste material in limestone, freight is not being paid on the clay used, as it would be if finished cement instead of limestone were shipped from the quarry. If clay or shale were equally available at either place, and if limestone were moved from the quarry to the city instead of cement, about 120 pounds of limestone would be moved instead of 100 pounds of cement. Actually, the differential in the cost of transporting a heavier weight of limestone is reduced and sometimes eliminated because limestone needs no protection from weather and moves under a lower freight rate than does cement.

WORLD PATTERN OF PRODUCTION

The world production of portland cement has been increasing at a rapid pace since 1900, and today makes up about 98 per cent of world cement production (Map 14.1). Production more than quadrupled from 1924 to 1960, in-



14.1. World—Cement Production—1960.

creasing from 51,300,000 to about 275,000,000 metric tons. The cement industry is especially widely distributed, with some cement production in nearly every country in the world. Because of the widespread distribution of cement's raw materials, its low cost, great bulk, and consequent high cost of transportation, there is a growing tendency for a country to meet its needs by producing its own cement. Adequate supplies of cement are important in the advancement of the underdeveloped areas of the world, and cement production is increasing substantially in many of these countries from year to year. For example, such industrially backward nations as Bolivia, Paraguay, and Iran are developing a cement industry.

Although many countries have developed a cement industry, the following produced five million metric tons or more in 1959: the United States, 66.8 million; the Soviet Union, 42.7 million; West Germany, 25.1 million; Japan, 19.0 million; Italy, 15.6 million; France, 14.7 million; United Kingdom, 13.8 million; mainland China, 13.7 million; India, 7.6 million; Canada, 6.2 million; Spain, 6.1 million; Poland, 5.8 million; and Czechoslovakia, 5.2 million. These 13 countries produced about 75 per cent of the world's total. The world production of cement has been increasing at an annual rate of 5 to 10 per cent in recent years.

North America. The United States has been the leading cement producing nation since the early 1900's, and thus dominates North American output, with nearly 90 per cent of the total. Canada has a well-developed cement industry, producing about 6,200,000 metric tons annually, about 7 per cent of the continent's output. The Mexican cement industry has been growing in importance and now produces about 3 per cent of the North American total.

Europe and the Soviet Union. Europe, as a continent, is the world's largest cement producer. Production has increased rapidly since the early 1920's, from nearly 20 million metric tons in 1925 to over 140 million metric tons in 1959. Production is centered in the northwestern European countries. West Germany is the leading European producer and ranks third in the world. Although production in Germany declined greatly in the latter part of World War II, there has been a remarkable recovery in the postwar period. By 1950 Germany had regained its European leadership. Italy is the second-largest producer, followed by France, United Kingdom, and Spain. These five countries produce about two-thirds of the total European output.

Other important portland cement producers in Europe are Poland, Czechoslovakia, Belgium, East Germany, and Sweden.

The cement industry of the Soviet Union has been greatly enlarged since 1928. Within the nation cement is possibly the most important building material, not so much for housing construction, but for the building of various gigantic projects such as hydroelectric power installations and factories. The output of cement, increasing from 11 to 16 per cent annually, has risen from 6,455,000 metric tons in 1948 to 42,760,000 metric tons in 1959. The seven-year plan (1959-1965) calls for an increase of at least 12 per cent each year (10).

Asia. Asia is the third continent of significance in portland cement production, with about 11 per cent of the world's total. Japan, communist China, and India dominate production, with about 70 per cent of Asia's output. Production of cement in communist China has increased tremendously from 660,000 metric tons in 1948 to over 9,300,000 metric tons in 1959. The expansion of the cement industry in Japan has been equally spectacular, with production rising from 1,859,000 metric tons in 1948 to 19,034,000 metric tons in 1959. As industrialization advances in Asia, it can be expected that the cement industry will grow. Most countries have included among their specific development projects the expansion of cement production.

South America. Although South American production is still relatively small in comparison with North American and European output, the industry has shown rapid expansion. Before World War I Latin America was one of the world's largest import markets for cement. Because of the lack of shipping during the war years a native portland cement industry was established, the first plant being opened in Argentina in 1919. By the mid-1930's, Argentina, Brazil, Bolivia, Chile, Colombia, and Uruguay were almost self-sufficient in portland cement. Specialty cements were still imported, however. Imports also were required to meet the market demands of outlying territories reached more easily from foreign than domestic sources. European countries—chiefly Germany, Belgium, and, to a lesser extent, Sweden, United Kingdom, France, and Italy—dominated the cement trade with Latin America before World War II. European manufacturing costs were much lower than those in the United States, and transportation expenses were kept particularly low because of the two-way trade that had been developed.

During World War II European producers were once again blockaded, and, with South America being in the process of industrialization, the demand for cement was high. Production continued to increase throughout the war and postwar periods, going from 2,673,000 metric tons in 1939 to over ten million metric tons in 1960. Brazil is the largest producer of cement in South America, followed by Argentina, Venezuela, Colombia, and Chile.

The demands for cement will continue to grow in South America. Industrialization is linked with transportation. While modern highways are scattered sparingly throughout vast areas of Latin America, they must multiply as the demands of industry increase and a higher scale of living is attained. The arid climate of many regions creates a demand for the construction of dams and irrigation works, and a continent poor in coal reserves but with abundant water power inevitably must direct its energies toward the construction of hydroelectric power plants. The Latin American countries are rich in exportable raw materials but have few natural harbors, and concrete breakwaters and docks are urgently needed. The demand for concrete in houses will also grow. Standards of living are relatively low, and perishable building materials are widely used. As living conditions improve cement will be used increasingly in home construction. Already, many countries are undertaking extensive public-works programs.

Africa. The Union of South Africa is the largest cement producing country in Africa, with about 35 per cent of the continent's output. Production is small in all other areas. The growth of the cement industry has been handicapped by a lack of fuel in Africa. It can be expected that output will grow as the industrialization and general development of the African economy progresses.

UNITED STATES

Development of the natural cement industry. The natural cement industry was developed in the United States more than 50 years before the first patent was secured for the manufacture of portland cement. The construction of canals in this country was the greatest impetus to the expansion of natural cements, since canals required watertight masonry. Because of this need the first natural cement was produced in New York state in 1818. The construction of canals furnished the largest market for natural cement for many years, and as these waterways at that time furnished the only means of transporting bulky materials, the industry developed along canal routes. In 1866 the first cement mill was built along a railroad in Indiana. It was a success, and most new cement mills were built along railroad or canal routes after this date.

The manufacture of natural cement was a comparatively simple operation. The natural cement rock, found in many places in the United States, was heated in small upright kilns at relatively low temperatures for approximately one week. The clinkers were then ground between millstones operated by water power. Either wood or coal was used as fuel, depending on which was available. Natural cement was thus a direct product of natural rock.

Since the raw materials used were nearly the same throughout the country the natural cement produced had a uniform quality. It gained acceptance in the building trades at an early date and competed successfully with portland cement for more than 25 years. Production of natural cement continued to rise throughout the nineteenth century to a peak in 1899, when 1,683,000 metric tons were produced.

At this time there were three centers of production, each originally located on a canal route. The principal center was the Rosendale Natural Cement District in Ulster County, New York. About 50 per cent of the total cement output came from this one district. The second-largest area was developed near Louisville, Kentucky. The quality of this cement was excellent and it was marketed throughout the interior United States. The third center of importance was the Lehigh District of Pennsylvania. Natural cement production began here with the construction of the Lehigh Coal and Navigation Company Canal. Fifteen states, with 60 to 70 plants, were producing natural cement in 1890.

Establishment of portland cement industry in the Lehigh District. The first portland cement was produced commercially in the United States in the Lehigh District of eastern Pennsylvania in 1875. For the next 25 years the Lehigh District maintained a near monopoly in the production of this cement. In 1897, the year of its greatest dominance, this single district produced 74.8 per cent of the country's total output. The early importance of this district was due largely to the availability of large quantities of natural cement rock and its position near the important eastern market. During this period it was believed that the natural cement rock of this region was superior to any other limestone in the United States.

American portland cement was not readily accepted in this country. Two factors were particularly important in its rather long period of retarded growth. The natural cements had gained a national reputation as quality products and many builders preferred to use them. European portland cement was also imported into this country before the American industry was established. Until about 1890 these cements could be brought to the United States and sold at a price below that of the native portland cement. The foreign cements also gained a good reputation, which gave them a preferred market.

However, by the 1890's Lehigh District cement was gaining wide acceptance. It was being sent to every section of the country, and even developed a small export market. As a result production increased from 57,150 metric tons in 1890 to 1,447,000 in 1900. It thus took about a quarter of a century to establish the American portland cement industry (8).

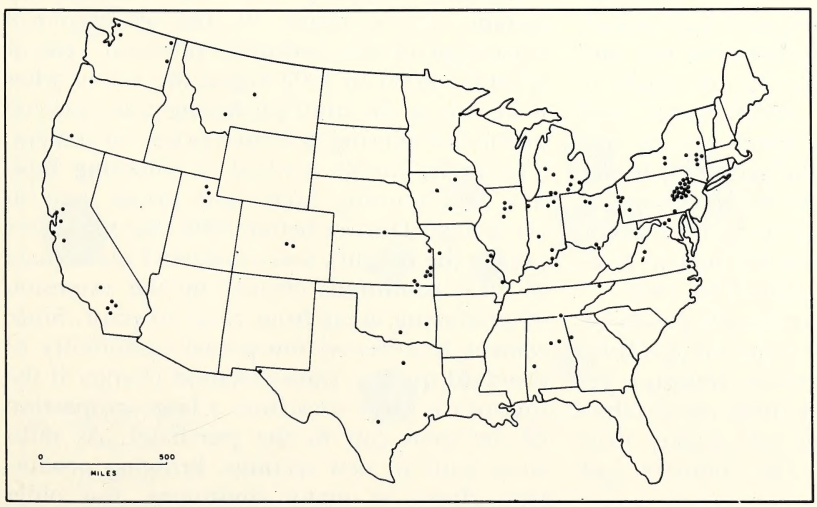
Decentralization of the cement industry, 1900-1920. As the nation's cement production expanded to 17,063,800 metric tons in 1920 many new cement plants were constructed outside the Lehigh District. In 1900 the eastern states—Pennsylvania, New Jersey,

and New York—produced nearly 80 per cent of the country's total and the next most important region, the north central states, produced about 19 per cent. The locational change was so rapid that by 1905 the East Coast produced only 55 per cent of the total, and output in the north central states had risen to 30 per cent. The western states, particularly those on the Pacific Coast, were rapidly expanding production, and produced a little over 10 per cent of the total by 1905. The number of cement plants in the country increased from 50 in 1900 to 88 in 1905. The greatest expansion in the first decade of the twentieth century took place in the Michigan marl deposits, the Kansas gas fields, and the limestone area of northern Ohio. The decentralization of the cement industry continued at a less rapid pace after 1905. However, by 1920 cement production was found in 27 states (Maps 14.2, 14.3). The Lehigh District remained the largest single district, with about 26 per cent of U.S. output. The north central states and the Pacific Coast combined produced about 35 per cent of the nation's total in that year.

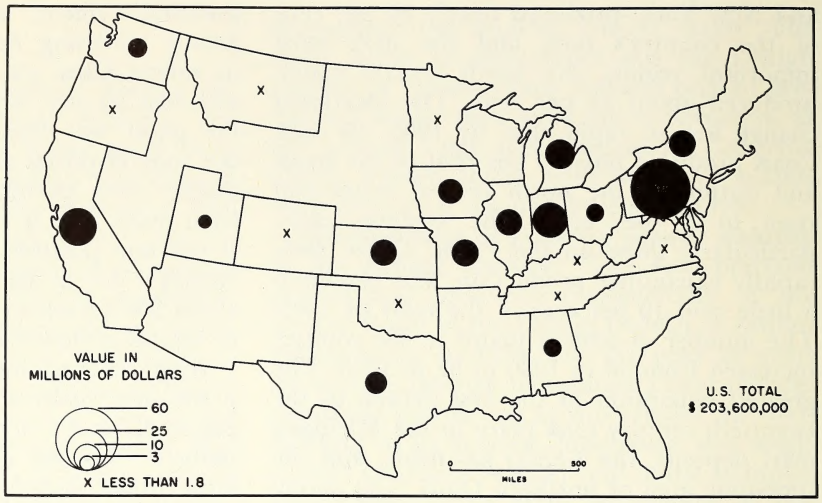
Factors influencing decentralization. There were a number of important factors that caused the widespread expansion and growth of the industry. In the two decades from 1900 to 1920, complete mechanization of the industry was achieved. The introduction of the rotary kiln was the most significant technical advancement. It revolutionized the making of portland cement, while at the same time greatly widening its markets. Cement made in rotary kilns was much better in quality and cost 25 per cent less. The total cost of the plant was also materially reduced, and the time required to convert the rock at the quarry into portland cement was reduced from more than a week to only a single day. It was now possible to produce 1,200 to 1,500 barrels a day as against a unit production of about 200 barrels in from ten to fourteen days in the old style-vertical kilns.

With the introduction of the rotary kiln, it was soon realized that a wide range of raw materials could be used. Thus, the cement industry was no longer restricted to those areas where natural cement rock was found. A standard, uniform quality of cement could also be produced from a wide variety of raw materials. Until 1904 the manufacturer established his own standards. In that year the American Society for Testing Materials established standards so that all cement would be of the same quality. Thus, cement became a highly noncompetitive product.

The success of the rotary kiln was made possible with the introduction of powdered coal. Coal fields were associated with many of the new areas of cement production and from 1900 to 1920 coal furnished 80 to 85 per cent of the fuel consumed. Early in this period natural gas was also found to be an excellent fuel and was used wherever readily available, notably in Kansas.



14.2. United States—Portland Cement Plants—1920.



14.3. United States—Portland Cement Production—1921.

Besides the rotary kiln there were several other technical advancements. The mills which ground the clinkers were enlarged, and iron and steel replaced the old stone grinders. Plaster of Paris was introduced to retard the rapid setting of portland cement, which had long limited its use. Steam shovels which facilitated the handling of the bulky raw materials were introduced in the quarries. Finally, the first cement and concrete laboratories were established, located in the Lehigh District.

The increased mechanization greatly reduced the price of cement. In the early days of the portland cement industry one of the significant problems was the high price of American cement. From the earliest times the manufacturer was confronted with high priced labor, and economy in this direction was one requisite of success. Mechanization made it possible to reduce labor requirements and thus produce cement at a lower cost in this country than in Europe. The price of a barrel of cement declined from $3.00 per barrel in 1880 to a record low of 81 cents in 1912. From peak imports in 1893 of 456,300 metric tons, imports had all but disappeared by 1908.

Once portland cement was cheaply produced in large quantities and its superior qualities recognized, the natural cement industry declined rapidly. Although in 1900 the production of natural cement was still greater than that of portland cement, the industry had almost vanished by 1915.

The last factor—and one of great importance—in the decentralization and expansion of the portland cement industry was the rapidly expanding market after 1900. Until about 1915 the greatest market for cement was for public and commercial buildings, bridges, levees, and specialty uses. Between 1910 and 1920 the concrete highway was developed. This single use soon became the most important market, and as early as 1921 4,380 miles of concrete highways had been built, consuming 4,266,200 metric tons of cement—about one-quarter of the country's total output. Because cement was bulky, heavy, and had a relatively low value, plants were constructed near the market in order to reduce transportation costs.

Cement industry and the basing-point system. As a result of the geographical expansion of the industry, portland cement manufacturers in 1902 began the use of what is known as the multiple-basing-point pricing method of quoting delivered prices for cement. The early, simple method of soliciting business and quoting f.o.b. mill prices used in the Lehigh District before 1900 (the purchaser paying the freight), was considered inadequate to meet conditions created by the extension of producing areas from coast to coast. Since cement is a heavy, low-priced commodity of standard quality, transportation charges if the distance is great constitute a large proportion of the total cost to the purchaser. As mills were built in new sections, bringing production closer to many consumers, the older

mills were forced to absorb a part of the freight costs or withdraw from the market near the new mills. This led manufacturers to adopt the practice of adding the freight costs to the mill price and quoting an f.o.b. destination price. This practice, with few exceptions, was adopted by all cement manufacturers and became a convenient and accurate means of achieving uniform quotations by all manufacturers at any point of consumption. The basing-point system of pricing enabled a distant mill to quote a delivered price equal to that of a competitor located nearer the buyer.

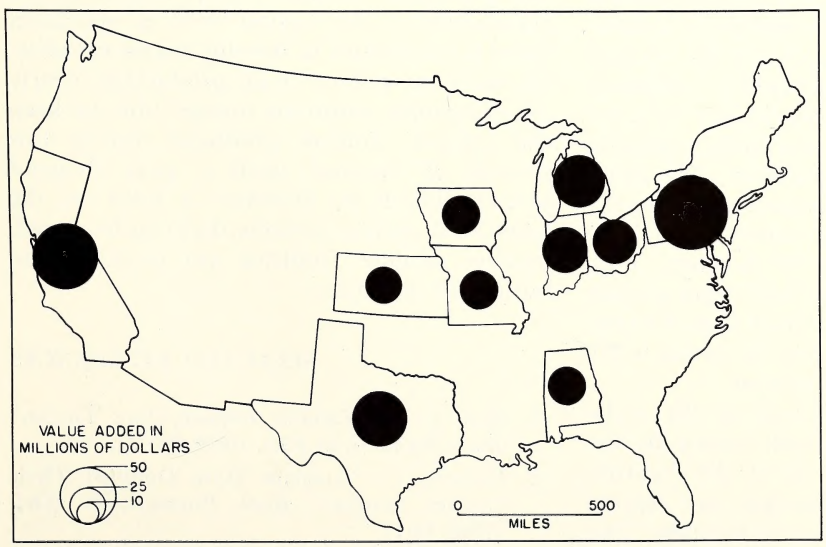
Serious questions concerning the legality of all geographic pricing formulas—except f.o.b. mill—were raised as early as 1921 by the Federal Trade Commission. The issue of basing-point selling was brought into sharp focus by the decision of the U.S. Supreme Court on April 26, 1948 in the "Cement Case." The decision declared that the maintenance of a basing-point-of-delivered-price system was an unfair method of competition and as such was prohibited by the Federal Trade Commission Act.

Since 1949 all portland cement producing companies have abandoned the basing-point system of pricing. This marketing change appears to have had little influence on the location of the industry, largely because most plants were originally market oriented. A few plants located farthest from their market have disappeared, and the plants nearest the largest markets have increased in size.

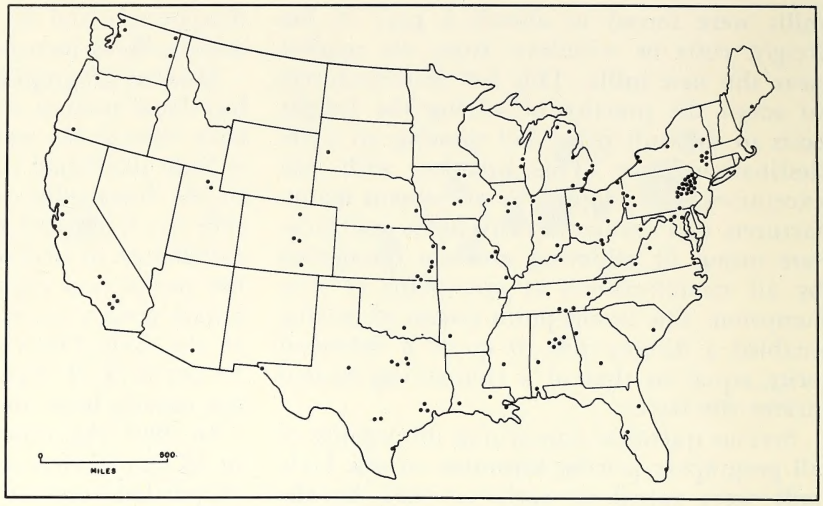
Modern geographical structure. The basic locational pattern of the cement industry has been remarkably stable since 1925 and there is little likelihood that it will change greatly in the foreseeable future. Although production has fluctuated from a low of 10,905,000 metric tons in 1933 to over 66,800,000 in 1959, the production capacity of the industry has always greatly exceeded demands (Map 14.4). In the early 1930's production was less than 30 per cent of capacity and in recent years has usually been about 80 per cent.

In 1961 the cement industry was located in 38 states. However, about 80 per cent of all portland cement plants are in the Middle Atlantic and Middle Western states. The Lehigh District remains the largest center of production, with 21 plants and an annual output of about 9,400,000 metric tons. This is approximately 14 per cent of the national total. Pennsylvania is followed in production by California, Texas, New York, Michigan, Ohio, and Alabama.

The industry is composed of about 103 companies with 156 plants. The five leading companies (Universal-Atlas, Lone Star, Lehigh Portland, Ideal Cement, and Penn-Dixie) control about 40 per cent of the industry's total capacity. The five companies next in size control an additional 15 per cent of the capacity. These are the leaders in the indus-



14.4. United States—Cement Industry—1958.



14.5. United States—Portland Cement Plants—1960.

try, and they are generally followed by the smaller companies in policy matters. Most of the large companies have decentralized their production by constructing plants near the great market areas. This is because of the limited demand in any one market area and the difficulty of competing in distant markets because of high transportation costs.

Production characteristics. Production is characterized by wide seasonal fluctuations, and the cement industry is particularly sensitive to general economic conditions. The construction industries, including roads, are the major consumers of cement, and since cement is largely used out of doors the demand is high during the warm and low during the cold seasons. This is in part because of inclement weather conditions and partly because of custom. While considerable technical progress has been made in laying concrete under winter conditions, the milder months are still favored for construction. The influence of road-building and construction in the cement market, therefore, causes it to have wide seasonal fluctuations in demand. Shipments of cement are two to four times greater from May through October than from November through April. The curve for stocks is the reverse of the curve for shipment.

Of even greater significance is the wide, cyclical fluctuation in demand caused by the general economic conditions of the country. Except for its seasonal changes, the cement curve is a useful barometer of business. The cyclical variations are due to the importance of cement in the construction business. Construction activity is determined largely by general business conditions, rising to considerable proportions in times of prosperity and dropping to low levels during times of depression. This wide range in demand poses a problem to the cement industry. To serve the market, it is necessary to have sufficient capacity to meet the peak seasonal and cyclical demands. A cement mill must operate on a continuous 24-hour basis. The output is determined by the number of kilns in operation. For example, in a four-kiln mill only four levels of operation are possible: 25, 50, 75, and 100 per cent. Because equipment must be maintained at the highest level of operation there is a tendency to develop excess capacity. In order to reduce peak production nearly all companies maintain storage bins to keep the cement clinkers produced during low periods of demand until a peak demand period. There is, however, a limit to the amount of cement clinkers that can be stored, because storage facilities are expensive to build and maintain.

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COTTON TEXTILE INDUSTRY

CHAPTER FIFTEEN

The cotton textile industry is one of the oldest forms of manufacturing, and remains today one of the most important. This industry provides a basic need of human existence—clothing for body protection. It originated as a home handicraft industry in Asia and the Western Hemisphere before 3000 B. C. With little advancement in technology from the spinning wheel and hand loom for centuries, the mechanization of the textile industry spearheaded the Industrial Revolution in Europe and America (9).

At the present time the textile industry is one of the largest types of manufacturing in the world in terms of number of people employed, gross value of output, and share in international trade. Total employment in the textile industry is about 25 million workers, of which about 15 million are employed in cotton textiles. The proportion of workers employed in the cotton textile branch of the industry varies considerably from country to country. In India about 75 per cent of the textile workers produce cotton cloth. In other countries the percentage varies from 60 per cent in the Soviet Union and 40 per cent in the United Kingdom to about one-third of the total textile workers in the United States.

WORLD COTTON SUPPLY

World production of raw cotton has increased steadily since the beginning of the modern textile industry. Annual world output has risen from about 6,500,000 tons in the 1930's to 10,800,000 tons in the 1960's. Although cotton is produced in about 60 countries, eight nations produce between 85 and 90 per cent of the total supply.

Of the producers, the United States occupies a predominant position. Before 1930 it produced about 60 per cent of all cotton grown in the world. Because of domestic restrictions and the increase in other countries, the United States now produces about 50 per cent of the world's commercial cotton. The Soviet Union is the second largest producer with approximately 10 per cent of the world's output.

Other nations of importance in cotton production are India with 7 per cent of the world's output; Egypt, 6 per cent; Brazil, 4.5 per cent; Pakistan, 3.2 per cent; Mexico, 3.0 per cent; and China, 2.4 per cent. Minor cotton producers include Uganda, 1.9 per cent; Argentina, 1.7 per cent; Turkey, 1.5 per cent; Peru, 1.2 per cent; Sudan, 1.0 per cent; and the Congo, 0.8 per cent.

Many of the cotton textile producing regions or nations produce little or no raw cotton. These include New England, United Kingdom, the countries of Western Europe, and Japan. As a result, cotton must be imported, making it one of the most important commodities in international trade. Among the countries which consume most of the cotton they produce are the Soviet Union, India, China, Korea, and Argentina. Among the countries which export large portions of their output are Pakistan, Egypt, Brazil, Mexico, Peru, Sudan, Uganda, the Congo, Iran, and Turkey. The great majority of the small cotton-producing nations export a considerable percentage of their output. The United States is both a large consumer and exporter of cotton.

WORLD COTTON SPINDLES

From the beginning of the modern cotton textile industry until 1928, the number of spindles increased steadily to an all time high of 165,103,000. With the world's rapidly expanding population and improvements in standard of living, there was an increasing demand for cotton textiles for clothing, home furnishings, and industrial uses. Although the world production for cotton fabrics has continued to grow, the number of cotton spindles has steadily decreased since 1928 to 137 million in 1939 and to fewer than 119 million in 1960.

With a continued rise in cotton consumption it is evident that the present spindles are producing more cloth. There are several reasons for this trend. Among these are longer hours of spindle operation. For example, in the United States a 40-hour work week was adopted in 1933 as part of the Cotton Textile Code. As a result, many mills operate on two 40-hour shifts rather than working one 48 to 60-hour shift per week. Comparison of operating time for the spindles in 1927, 1937, and 1947 in the United States is revealing. The 1947 spindle ran an average of 223.8 24-hour days, compared with 165.4 24-hour days in 1937 and 133.7 24-hour days in 1927. On a percentage basis the 1947 spindle ran 35 per cent more hours than the 1937 spindle and 65 per cent more than the 1927 spindle.

There has also been an increase in the efficiency of the spindles. This has been the result of two developments. First there has been the substitution of rapidly-producing ring spindles for the slow-producing mule spindles; and secondly, there has been an increase in the efficiency of the ring spindles themselves. The number of mule spindles has declined from 36 million in 1939 to about 16 million in 1960. The mule spindle has all but disappeared from all countries except the United Kingdom, where about 90 per cent of the world's mule spindles remain. The predominance of the ring spindle is due to its great efficiency and economy. On the ring spindle, spinning, twisting, and winding onto the bobbin take place simultaneously and continuously. On the mule spindle, spinning, twisting, and winding are individual operations. The ring spindles have also become increasingly efficient. In the United States, for example, each spindle each hour it ran produced 15 per cent more in 1947 than in 1937 and 28 per cent more than in 1928. Thus, in 21 years the productivity per spindle increased an average of 38 per cent.

The number of spindles in the world has not only declined since 1928, but their geographic distribution has also changed. In the United Kingdom the number has decreased from about 56 million in 1928 to 25,100,000 in 1960. The United States has also experienced a decline from a peak of 37,800,000 spindles in 1924 to 22,240,000 in 1960. In contrast the number of spindles in the Soviet Union rose from 6,700,000 in 1920 to over 12 million in 1960. The number of spindles has also increased in several of the smaller producing countries such as Brazil, Mexico, Portugal, and Australia. The number of spindles has been fairly stable in France, Germany, Sweden, Canada, and a number of other countries.

WORLD COTTON LOOMS

The number of cotton looms in the world's factories has followed approximately the same general trend as spindles. The peak figure of three million was achieved in the 1920's. The number has decreased until in 1960 it was but 2,430,000. There is a wide variety of looms in use in the world. Looms differ as to the speed at which they operate, the width of cloth they produce, and the number of workers needed to operate them. Hand looms are still found in many regions, particularly in the Oriental countries. In many of the countries where the factory system of textile production began early, such as Western Europe, the nonautomatic loom still persists. The automatic loom is widely used in the United States and Japan. The efficiency of the automatic loom is of importance in the low-cost production of standard cotton fabrics. A single weaver, with some assistance, can tend 60 automatic looms, whereas four to six looms are the customary assignment to a weaver of the nonautomatic type.

The geographic distribution of looms has been considerably altered during the twentieth century. At the beginning of the century the United States and the United Kingdom had more than three-fourths of the world's looms. As other nations developed a textile industry, these countries declined in relative position. Besides this, there has also been an absolute loss in the number of looms in these countries. In the United States the increase in modern, efficient looms in the South has caused abandonment of the older looms in New England. The decline in the number of looms in the United Kingdom has been caused by the loss of foreign markets, particularly in the Orient. The United States and the United Kingdom now possess between one-quarter and one-third of the world's looms.

In contrast, a great many countries have increased the number of their looms. In the Orient, particularly in Japan and India, there has been a steady growth of looms in the mills. The Soviet Union has also expanded the number of its looms, as well as such newly developed textile nations as Brazil, Egypt, Turkey, and others. At present Europe has about 47 per cent of the world's looms, Anglo-America 20 per cent, Asia about 20 per cent, the Soviet Union, 8 per cent, and Latin America about 5 per cent.

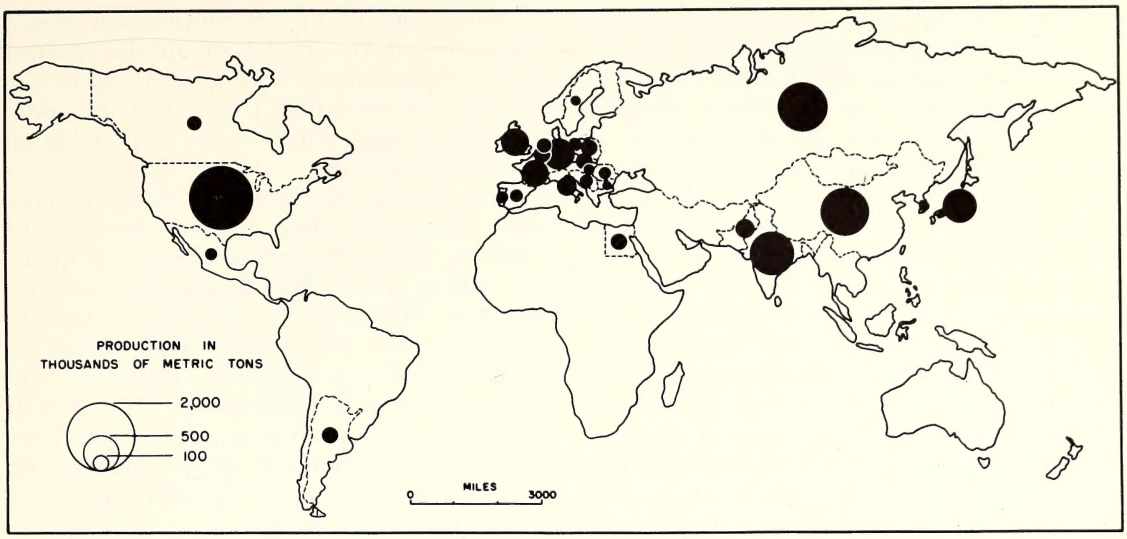
DISTRIBUTION TRENDS IN THE WORLD COTTON TEXTILE PRODUCTION

The mechanized cotton textile industry was one of the first—if not the first—industries to stimulate the Industrial Revolution. The United Kingdom inaugurated the revolution, and as a result the cotton manufacturing center was transferred from the hand looms of India to the North Atlantic countries of Western Europe and the United States. During the nineteenth century the United Kingdom and the United States dominated the production of cotton textiles, with lesser centers in Germany, France, and Russia.

At the beginning of the twentieth century new forces in the localization of cotton textiles were appearing, causing a shift in the distribution of production. Of the distributional changes, the rise of the industry in the Orient and the migration of mills from New England to southern United States were outstanding events. India was the first nation in the Far East to adopt mechanization of cotton textile production. The growth in Japan followed. The shift from New England to the South had become significant by the early 1900's.

In the period after World War I another change in world cotton manufacturing began, and, it is still in progress (12). The growth of cotton textile manufacturing has been taking place in many small countries and especially in the cotton producing countries of South America, Africa, and Asia. This trend has been encouraged by the efforts of most countries to develop national self-sufficiency. Because the cotton textile industry requires a minimum of skilled labor it is one of the first industries to be established in a country just starting its industrialization. Also, the low cost of domestic raw cotton in comparison with the high prices of imported textiles has promoted the textile industry in the process of developing a better balanced economy in the underdeveloped nations.

In recent years about five million tons of yarn and 25 to 30 billion yards of cotton fabrics have been produced annually (Map



15.1. World—Cotton Yarn Production—1960.

15.1). Although a cotton textile industry has been established in most countries of the world, it is still concentrated in a relatively few nations. Using production of cotton yarn as the criterion, the six leading nations in 1960 were the United States, with 28 per cent of the world's total; the Soviet Union, 16 per cent; India, 12 per cent; Japan, 10 per cent; Germany, 6 per cent; and United Kingdom, 5.5 per cent. These six nations produced 77.5 per cent of the world's cotton yarn.

FACTORS OF LOCALIZATION

The factors affecting the localization of the cotton textile industry are generally complex (1). Each region has its own history. In many instances the older areas continue to grow even when the original causes for the establishment of the industry have disappeared. In other instances, textile centers that were once important have declined and are of little significance today.

The earliest cotton textile centers prior to the Industrial Revolution were usually localized by the availability of raw material. The production of cotton in India is considered the historical base for the ancient industries of spinning and weaving cloth found in the Indian home. However, the textile industry has been able to detach itself from its raw material base. As early as the thirteenth century Flemish and Italian weavers were importing wool from England. This represents the beginning of the trade that reaches the farthest regions of the world today. The decreasing importance of raw material as a localizing factor is due to the ease in transporting not only the raw material but also the finished product to its ultimate market. Cotton is easily transported great distances from its area of production when human factors in the cotton producing regions have not permitted the growth of a textile industry.

The importance of power has varied in localizing the textile industry, depending upon the existing state of technology. In the beginning there was human labor, which permitted a degree of mobility in locating the industry. With the introduction of water power the textile industry became precisely localized. Watercourses were the first places where mechanical equipment could be utilized, as for example in the valleys of the Vosges in France, at the mouth of the valleys of the Prealps in Switzerland and Italy, and in the foothills of the Pennine Range in England. This localization factor persisted from the middle of the eighteenth into the nineteenth century. Coal gradually replaced water power as the primary source of power. Steam power

has been utilized most easily in the vicinity of the coal basins, and coal has been a major element in localizing the cotton textile industry in such areas as Lancashire, northern France, the Ruhr, and Saxony. The use of coal in providing motive power did, however, give a greater flexibility in the localization of the industry. Textile factories located at some distance from coal sources are concentrated at places where coal can easily be transported at the lowest possible cost. For example, its excellent railroad facilities give Mulhouse a decided advantage over the isolated textile centers in the uplands of interior Alsace, and the low cost of shipping coal to Flanders and Brabant gives these areas an advantage. In the twentieth century the use of electricity to power textile factories has made possible a wider distribution of the industry. The availability of power continues to play a role in the localization of textiles, but its influence has lessened with each increase in power mobility.

The presence of a particular type of labor is frequently stated as a decisive factor in the localization of textile mills. This is justified in a large number of cases. In many of the underdeveloped countries the textile industry is the first type of manufacturing to be established in order to absorb an excess rural population. In the more economically advanced nations the textile industry is frequently established to provide work for those regions which possess an excess labor supply. The textile industry is frequently the first industry founded in an area, not only because it provides for a basic human need, but also because it requires an absolute minimum of technically trained personnel for its implementation. The labor force for the textile industry comes not only from the male population, but from women, children and older people as well. In many instances this industry is associated with other types of manufacturing in that the men are employed in the heavier industries and the women work in the textile factories. Because of the minimum training needed and the resulting low wages paid by the industry, textiles frequently are localized in those areas of a nation where the lowest wage rates prevail. For example, the textile industry is shifting from the high wage area of New England to the considerably lower wage area of the Piedmont in the United States. Thus, the number of workers is not the only consideration. The cost of the labor also has its importance in the localization of the textile industry.

In a number of instances, textile regions have developed from a particular market situation. Many countries of the world desire not only to produce goods for domestic consumption, but also to provide an export commodity for the nation. The classic example of this situation is found in the Lancashire region of England. The British industry was established to produce cloth for a world market. Similarly the Japanese textile industry was established to provide an export commodity for the nation.

UNITED KINGDOM

The United Kingdom developed the first modern cotton textile industry in the world, dating from the end of the eighteenth century. The technical advantages given by the invention of Arkwright's water wheel and Crompton's mule loom, along with later inventions, provided Britain with an economic and technological advantage in the world textile industry for more than a century.

Initial localization. Before the introduction of cotton textiles, the woolen, linen and silk industries were highly developed in Great Britain. In the eighteenth century the major factors localizing the textile industries were available water power and high humidity. Because water power is widely distributed and all of Great Britain possesses high humidity, the textile industries were widely distributed. At the beginning of the nineteenth century textile factories were located in Nottingham, Wales, the Scottish Lowlands, West Riding, Kendal, Carlisle, Lancashire, and Northern Ireland. Because cotton could be substituted for other textile raw materials, the early cotton textiles were produced in established textile centers.

Centralization in Lancashire. Shortly after the beginning of the nineteenth century, the cotton textile industry began a rapid centralization in the Lancashire region (Map 15.2). A number of factors adversely affected its



15.2. Europe — Textile Regions.

localization in other regions. As the industry changed from water power to coal for its power source, the early textile centers, lacking coal resources, were soon producing at a disadvantage. At the same time a number of the early textile regions having coal mining activity saw this activity shifted to the processing of iron ore because metal products yielded a higher profit. During this period the different types of textiles began to concentrate in those regions which possessed the greatest advantage to them. Woolens and worsteds localized in West Riding, linens in North Ireland, and cotton in Lancashire.

The Lancashire area possesses a number of favorable factors for the establishment of the cotton textile industry (2). Lancashire, in western England, has mild temperatures and high humidity. This was an important localizing factor in the early period, since the highest humidity possible was required to reduce the breakage of thread in spinning and weaving. The minimum relative humidity needed in cotton spinning is approximately 50 to 60 per cent. If the air is dry, there is much breakage of thread, causing delays and the production of poor-quality cloth. Because many areas have humidity conditions similar to Lancashire in Britain, the specific location in this area is not exclusively due to climatic conditions.

The availability of power—first from water and later from coal—was important in localizing the industry (20). Water power was most accessible in the foothills of the Pennine Range in eastern Lancashire, and this was a specific localizing factor in the early nineteenth century. With the conversion to coal for powering the mills, the availability of coal outcroppings in the Pennine foothills did not necessitate a shift in the location of the cotton textile industry. It is also important that Lancashire coal was largely noncoking in quality so that other industries, notably iron and steel, were not attracted to this region.

The availability of soft water was also a specific localizing factor for the industry in eastern Lancashire. In western Lancashire the water is obtained from underground sources and has a high calcium content, making it quite hard. In eastern Lancashire the water comes primarily from the immediate surface run-off of rainfall in the Pennines. This water is soft. In the bleaching, dyeing, and printing of cloth only soft water can be used.

Another factor influencing the localization of the textile industry in eastern Lancashire involves the general character of the land.

Eastern Lancashire is a hilly land, with stony, acidic soils. The rural people eked out a meager living from the grazing of sheep, which dominated the agricultural economy. The wool from these flocks furnished the earliest basis for a textile industry, and from the manufacture of wool products there was developed the body of skilled workers later utilized by the cotton textile industry. In contrast to eastern Lancashire, western Lancashire with its superior soil, lower rainfall, and warmer summers developed a crop agriculture that, although it could not supply the basic raw material for a textile industry, nonetheless provided a higher standard of living than eastern Lancashire from agriculture alone. The rural worker of eastern Lancashire could easily be enticed into his area's cotton textile factories, since it offered him a better living than his barren region could provide.

The combination of such factors as suitable climatic conditions, available soft water, local water power, and, later, coal and land-use conditions limiting the economic opportunities, were the major factors in localizing the industry in eastern Lancashire. After the industry was firmly established in the Pennine foothills, it gained greater and greater momentum. Because the raw cotton had to be imported and much of the finished product exported, the port of Liverpool was developed and canal and overland routes constructed to the interior. Manchester, in the heart of eastern Lancashire, became the financial center of the industry. For more than 150 years the economy of Lancashire has been dominated by the cotton textile industry.

Dominance in international trade. The British cotton textile industry developed in the nineteenth century primarily on the basis of a large export market. Prior to World War I, between two-thirds and three-fourths of the total output was exported. During the nineteenth century the English cotton industry provided hundreds of millions of people throughout the world with all kinds of cotton goods. The industry expanded steadily for over a hundred years. In 1850 when the United States had but 5,500,000 spindles and 92,000 workers, the British cotton industry had 21 million spindles and more than 330,000 workers. By 1913 the British industry possessed more than 55 million spindles and more than 800,000 looms. Production exceeded 12 billion square yards of cloth annually.

The rise to dominance of the British textile industry in world trade was based on a combination of favorable factors. The technical superiority of her cotton textile industry achieved in the latter portion of the eighteenth century made it possible for Britain to produce textiles at the lowest cost in the world. At the same time there was also a huge world market for cheap cloth. To secure raw materials and to reach the potential market, the British organized a world-wide shipping service. To encourage the flow of goods the British likewise advocated policies of free trade.

Decline of British cotton textile exports. Since the World War I period, the British textile industry has declined remarkably. The economic dislocations of World War I affected the industry adversely. Britain could not supply its foreign markets, and many countries enlarged their textile industry in order to attain domestic self-sufficiency. Some of Britain's largest customers developed huge textile industries of their own. For example, exports to India declined from more than three billion square yards in 1913 to less than 300 million in 1938. A number of countries, notably Japan, increased production so greatly that they offered tremendous competition to Britain. Other countries, such as Brazil, established high tariff barriers to protect their infant domestic textile industry from imports of British goods.

The spectacular decline of the British textile industry is unparalleled in modern industry. During the decade 1920-1929, exports declined 67 per cent below the 1904-1913 average. In the world depression of the early 1930's exports decreased to 35 per cent of the 1904-1913 period. There was no recovery prior to World War II, and the decline was even greater during the war years. Between 1918 and 1940, 800 cotton mills were closed, 21 million spindles destroyed, and 360,000 looms abandoned.

The trends in British cotton textiles have not been reversed since World War II. In 1960, when the home market consumed about 92 per cent of its prewar volume of woven

goods, total exports were 60 per cent lower. The proportion of domestic goods delivered to the export trade declined from 51 per cent in 1936-1937 to about 25 per cent in 1960. The cotton textile industry is increasingly dependent on the home market. The main reason for the loss in exports since 1945 has been the increasing competition from the United States, Japan, and countries of Western Europe. Moreover, the major portion of this competition has arisen in the higher quality textiles that the British industry is best suited to produce. The British textile industry has become a high-cost producer and is not able to compete with more efficient producing countries.

Effects of the decline of exports. The decline of exports has adversely affected every phase of the textile industry. The readjustments in the industry to declining markets are reflected in many ways. Besides a drastic decline in number of spindles, looms and factories, other influences are evident. The equipment has gradually grown obsolete and inefficient. In general, there has been little replacement of machinery or re-equipment of plants since 1914 largely due to lack of capital. The mule spindles that made Lancashire famous for fine quality cloth have lost their superiority. Since the mule spindle has a lower level of production than the ring spindle, this results in a higher cost production for Britain. In addition, mule spinning is almost wholly done by men, whereas ring spinning is largely done by women, a factor which also contributes to the higher production cost, since male wages are generally greater. Nevertheless, in 1960 Great Britain still possessed about 88 per cent of the world's mule spindles.

Other types of antiquated equipment also present a problem. Britain has few modern automatic and semiautomatic looms. To secure greater productivity with the old fashioned looms a system has been developed which has come to be known as "more looms to the weaver." This involves only minor mechanical changes in the looms, but requires a reorganization of labor in the weaving shed. The system has reduced the number of workers and, consequently, the labor costs.

Nevertheless, the productivity of labor is much lower than in the United States. The British Productivity Team that visited the United States in 1950 found that operative hours per 100 pounds of yarn produced were 138 per cent higher in the average mill and 93 per cent higher in the most efficient mills of Britain than in the United States. The number of spindles per spinner in the United States is 82 per cent greater than in England. The contrasts in the weaving branch are no less significant. A weaver in the United States operates as many as 104 automatic looms, compared to only 16 to 24 mule looms in Lancashire.

The Lancashire cotton textile industry was organized on a horizontal structure, which functioned best during the period of free trade in the nineteenth century. As a result, the different units of the industry—spinning, weaving, dyeing, and others—were independent, causing inefficiency of operation. Most of the countries of the world have a vertical economic organization in which all processes from the raw material to the finished goods are integrated. As the result of a declining market, amalgamation of companies and experiments in vertical organization have been in process for more than a quarter of a century. The amalgamation of companies has advanced considerably so that four companies now control about one-third of the total number of spindles. Although commercial organizations and the British government have favored the establishment of a vertical structure, there has been little development of integrated companies.

Because raw cotton accounts for one-half to three-fourths of the cost of yarn, the British industry has sought sources of cheap cotton. This is an obvious step in an industry anxious to lower its cost of production. There has been an increase in cotton imports from India and South America. In contrast the imports of cotton from high-cost areas have declined sharply. For example, by 1935-1936 imports from the United States were little more than one-third of the 1912-1913 period.

With the decline of the Asian market for the lower quality goods, there have been some attempts to develop new, and usually finer, fabrics. This is not a new trend, since the British industry has from its beginning created

new fabrics and new methods of finishing, as well as developing new uses such as automobile tire fabrics. If, however, a declining market is to be reversed by new fabrics, there must be a rapid and spectacular development (25). This requires a mammoth and costly research program. In the last quarter of a century the British industry has not had sufficient aggressiveness to implement such a program on a large scale.

Attempts to maintain the industry. Although the depressing influences have outweighed the attempts at recovery in the cotton textile industry, some measures have been taken over the years to achieve a degree of stability. During the 1930's price fixing, elimination of surplus capacity through scrapping of the older machines, and mergers of the smaller companies were instituted. The government has also granted subsidies and developed some constructive legislation to aid the industry. For example, in 1939 Parliament passed the Cotton Industry Reorganization Act to control competition within the industry. However, the outbreak of World War II made the act ineffective.

One of the most effective measures to preserve the export trade in cottons has come with the Ottawa Agreement on preferential custom rates within the British Commonwealth of Nations. The largest consumers of British textiles are Australia, New Zealand, the Union of South Africa, and the British Colonies. A trend has also developed for infant textile industries in British areas to send gray cloth to England for finishing, with re-exportation of the finished goods by England to the country of origin. British territories, as well as some Commonwealths, have engaged in this type of trade with England. This phase of the industry has been encouraged, since the British finishing plants have a monopoly on certain native designs and styles secured during the pre-World War II era when the quota system operating in the colonies limited competition from other countries.

Finally, it must be stressed that because the measures taken to stop the cotton textile industry's decline have been largely ineffective, there is fear that any change will cause further decline. The Lancashire textile producer often tries to maintain his industry through restrictive agreements largely developed in the 1930's. However, these agreements coddle the inefficient and also stifle the possibility of strong, aggressive management leadership. Labor unions, whose first objective is to maintain their working force, have attempted to stabilize jobs. These measures have been only partially successful because of the declining markets. Nevertheless, a larger number of workers has been maintained than necessary, making efforts to modernize the industry more difficult.

The future of the British textile industry does not look promising. Changing world conditions since 1920 have altered its position irrevocably.

UNITED STATES

The modern cotton textile industry of the United States had its origin in the last decade of the eighteenth century. The first cotton mill was built in 1790 in Pawtucket, Rhode Island. For several decades the industry grew slowly, but beginning with the War of 1812, during which time British imports were eliminated, the stimulus to expansion was great. To protect the growing, but still infant industry, protective tariffs were enacted. By 1840 cotton textiles were the leading American industry, with approximately 1,778,000 spindles and 75,000 workers.

Early localization of the industry. The early textile industry was predominately located in northern states, with the greatest concentration in New England. Within New England the textile industry was centered in the southeast from New Hampshire's Merrimack River to Fall River and New Bedford, Massachusetts and Providence, Rhode Island. The earliest mills developed at water-power sites so that all had river or stream locations. With the change to steam power beginning in the 1830's the mills were freed from their location on water-power sites. This gave greater freedom of a site selection. Many of the mills were then located on the coast, such as at Fall River and New Bedford, Massachusetts, where they had a tidewater advantage for the import of coal and raw cotton.

Factors in New England localization. New England possessed a number of favorable fac-

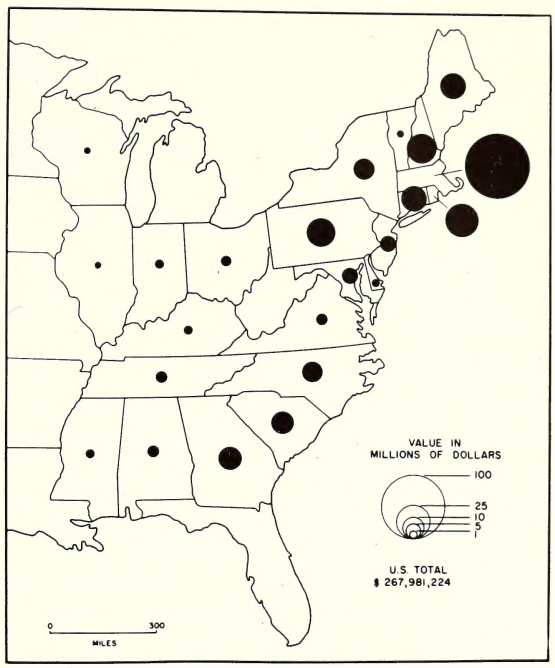
tors which encouraged the development of the cotton textile industry (6). The availability of water power was of the greatest importance. New England is a relatively small area so that the rivers and streams are also small. Because of limitations of dam building materials and technical know-how in the nineteenth century, only the smaller streams could be dammed for water-power utilization. The New England streams had nearly an ideal size for the harnessing of their water power. The streams also possessed other qualities that were desirable. New England is a humid, glaciated region, and there is thus generally an even flow of water throughout the year. The glacial lakes release the water from the headwater areas slowly, thereby regulating the flow of the streams.

The coastal position of southeastern New England also favored its growth. Since the raw cotton and coal had to be imported for the textile industry, and distant overland transportation was costly, a tidewater location made possible the assembly of fuel and raw material at a low cost. The shipbuilding industry developed partly as a response to the demands for raw material and fuel in the textile industry. At the same time, from the profits of the ocean shipping trade the textile industry was expanded. Traditionally the New England merchant has invested his capital locally.

The earliest New England settlers were skilled artisans, and spinning and weaving developed as a traditional industry in New England. With the establishment of the factory system skilled labor was available from the farms and from the wives and daughters of seafaring men. The introduction of the factory system made home manufacturing unprofitable, so that from the beginning of the textile industry a supply of trained labor was available which expanded as the industry grew.

The humid New England climate also aided the industry. Before artificial humidifiers were used to regulate the atmospheric moisture, the damp, cool area of southern New England uniquely favored the textile industry. Coastal New England possessed nearly optimum climatic conditions for spinning of cotton yarn. The textile industry also found it advantageous to be near the textile machine industry in order to have repairs to machinery completed quickly, and also to take advantage of new designs as soon as possible. Improvements in spinning and weaving were continuous throughout the nineteenth century.

Migration of the industry. During much of the nineteenth century New England held a dominant position in the production of cotton textiles. As late as 1890 about 80 per cent of the nation's spindles were located in New England (Map 15.3). Because the country's

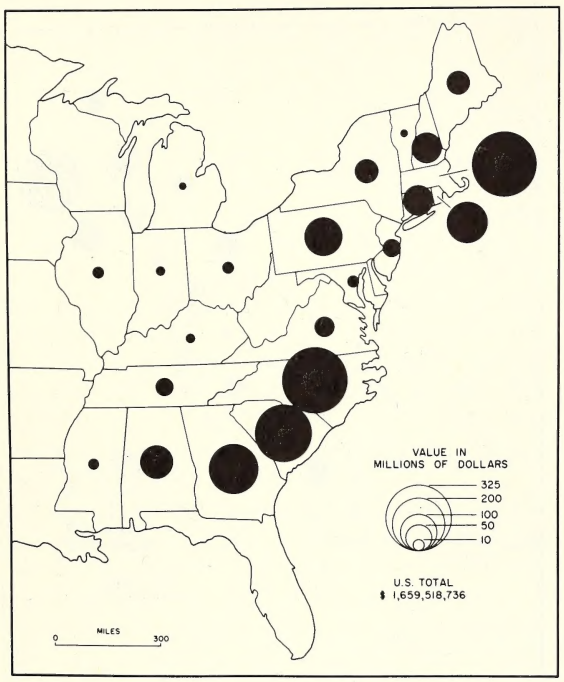


15.3. United States—Cotton Fabric Production—1890.

population was expanding there was a continuously rising market for cotton fabrics. The number of spindles in New England rose from over five million in 1850 to a peak of nearly 19 million in 1925. During the nineteenth century the cotton textile industry assumed an increasingly important role in the New England economy. Many towns developed as one-industry places devoted entirely to textiles.

Although the South produced the raw cotton for the New England industry, the cotton textile industry was slow to develop in this region. The invention of the cotton gin and the subsequent rise in use of cotton made cotton growing so profitable that the incentive for the manufacture of cotton cloth was largely

lacking in the South. The economic plight of the South after the Civil War, however, convinced southern leaders that industry was needed to revitalize the region. The cotton textile industry was the first modern industry to develop in the South. However, as late as 1880 there were but 561,000 spindles in the area in contrast to 8,632,000 in the Northeast.



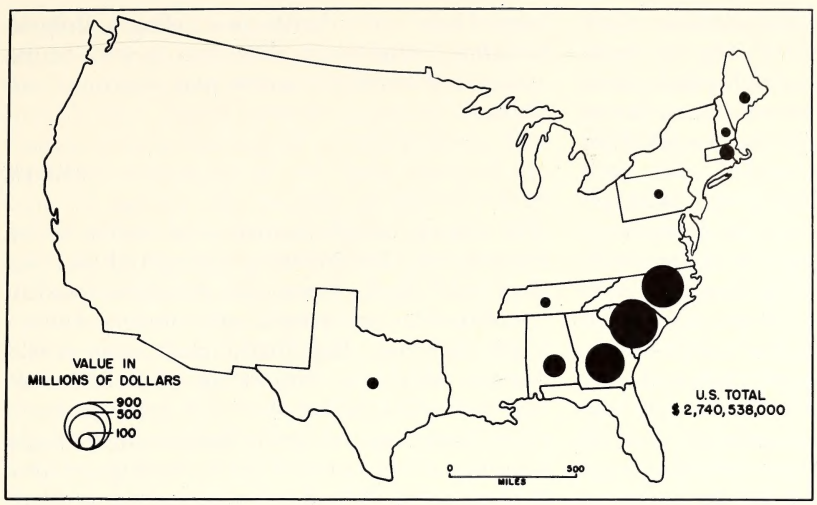
15.4. United States—Cotton Fabric Production—1927.

Rapid growth occurred after 1890 and by 1925 the South surpassed the New England states in number of spindles. In 1927 the value of cotton goods from a single southern state exceeded for the first time the leading northern state (Map 15.4). North Carolina in 1927 produced about 20 per cent of the nation's cotton goods, followed by Massachusetts, with 18.7 per cent, South Carolina with nearly 15 per cent, and Georgia with about 12 per cent (4).

As a result of expansion of spindles in both New England and the South during the early part of the century, overcapacity became a problem in the cotton textile industry. In the period of readjustment after 1925 with a decline in the nation's spindles, the decrease occurred almost wholly in New England. Although the number of spindles in the South has remained nearly stable at about 18 million since 1925, the spindles in New England have decreased from a maximum of 19 million to approximately three million. Actual relocation of plants reached a peak in the 1930's, but this trend has continued to the present. Between 1923 and 1948, for example, 90 cotton textile mills which employed 74,350 workers either liquidated or migrated from Massachusetts, removing an investment of $112,258,000. Census data on establishments in selected areas indicate that between 1880 and 1958 New England's proportion of cotton textile plants decreased by more than 50 per cent, while there was a more than fivefold increase in the number of mills in the Piedmont states of North and South Carolina, Virginia, and Georgia (Map 15.5).

Location of southern cotton textile industry. The southern cotton textile industry is concentrated in the inner Piedmont in the states of Virginia, North Carolina, South Carolina, and Georgia. In this area one is seldom out of sight of a cotton mill. The structures are usually one story and most of them are modern. The mills are normally in rural or suburban settings. Many of the towns are company built, and the textile payroll may be the only important one in town. The textile industry grew in the Piedmont in three ways: first, large northern corporations constructed branch plants; second, southerners constructed mills of their own; and third, northern mills, failing because of southern competition, were moved south.

Reasons for migration. Many reasons have been given for the migration and growth of the cotton textile industry in the Piedmont. One of the most commonly cited factors was that the industry was seeking the source of its raw material. This explanation is only partially adequate. In the early development of the industry the South was undoubtedly stimulated by the accessibility of raw materials. One estimate is that in the 1890's the Carolina Piedmont mills had an advantage in the transport cost of cotton of between 0.8 and 1.5 cents per pound of coarse products over mills in eastern Massachusetts. An even more significant transportation cost advantage was provided at this



15.5. United States — Cotton Fabric Production—1958.

time when southern railways offered special low shipping rates on finished cotton products to offset their competitive disadvantage in terms of distance to the northern market. These two advantages were important as an impetus to the early industry, but they did not last long. As the industry grew, local sources of cotton were no longer adequate and a large percentage of the raw cotton is now imported into the Piedmont from as far away as the Black Waxy Prairie of Texas. Also, as the industry grew, the railroads reverted to the normally higher rates for finished goods, so that southern plants actually operated at a cost disadvantage in shipping to northern markets. Transportation cost differentials on either raw materials or finished goods do not provide, therefore, a sound reason for the continued growth of cotton textiles in the Piedmont during recent decades.

In the cost of constructing and equipping factories, the South probably has little advantage over the North. Although materials and labor are somewhat less expensive, the cost of constructing and equipping factories is greater, since textile machinery must still be secured from New England.

A more significant factor in explaining the growth of the southern textile industry is the sizable differential in labor cost between northern and southern mills. An industry will seek that region where the greatest earning power is obtained. Production wages and salaries represent the largest share of mill costs, averaging about 25 per cent of the value of the product. Lesser costs include depreciation, fuel and power, taxes, marketing, and administration.

Because of the high proportion of labor costs to value of products, and even more significantly, because those costs constitute the major share of the mill margin, the industry may be considered labor oriented. The favorable differential in labor costs for the South has been and is the result of both lower wages and higher productivity of textile workers (15 and 16). In the 1920's it was estimated that the wages of textile workers in the Carolinas were 20 to 30 per cent lower than in Massachusetts. Although the differential in wages has declined, it still persists. In 1959, the average hourly earnings for cotton textile workers was $1.45 in the South as contrasted with $1.80 in New England. Because New England specializes in combed yarn products and southern plants are primarily engaged in carding yarn general comparisons are difficult; but individual companies verify that differentials do persist. The differentials have narrowed because of the influence of unions, government legislation pertaining to minimum wages, and the general increase in the level of the southern economy.

Even if wages were comparable in the two regions the South would still have an advantage because of higher productivity. The work assignments have traditionally been larger for southern textile workers, partly due to greater

adaptability and in some instances to more modern machinery and plants. The southern worker is less conscious of a delegated workload and has been more amenable to scientifically designed job assignments. In addition the tempo of technological change has been more rapid in southern plants and management has been more willing to experiment with new fabrics and techniques. As a result, a recent plan by an engineering firm for a mill of 450 looms indicated that in the South 118 workers would be needed, but in the same plant in New England 158 would be employed.

The South also possesses certain other economic advantages. The differential cost of fringe labor benefits results in a disadvantage to the northern segment of the industry. In the early stages of development benefits to the cotton textile workers were greater in the South than in the North. However, with the growth of unionism, the passage of liberal legislation such as unemployment insurance and workmen's compensation benefits in the northern states, and the increase of fringe benefits such as group insurance, paid holidays, and unemployment compensation, the costs to the northern mill operators are considerably greater than in the South. It has been estimated that the difference amounts to 8.5 cents per hour, accounting for a large proportion of the wage differential. The conclusion is evident that differences in labor costs have constituted the fundamental economic basis for the movement of cotton textiles from New England to the South.

Other factors have encouraged this migration. Power and fuel costs are substantially lower in the South than in New England, partly because of the climate and partly because of production and transportation costs. Southern plants need less fuel because of the milder climate, and transportation costs of fuel are less because major coal fields are nearby. Power costs are lower due to the dependence partly on hydroelectric power, and partly because coal is cheaper for steam-generated electric power. The southern states have also provided other inducements to attract the textile industry. These include lower taxes, capital at low interest rates, and physical inducements such as free plant sites and free buildings. Although these factors are of minor importance individually in causing a shift in location, collectively they are factors to be considered carefully when new locations are chosen.

INDIA

The cotton textile industry of India is extremely old. The initial spinning and weaving developed in the home as a handicraft industry. Prior to the nineteenth century India's light and fine handmade cloth was world famous. With the imposition of British rule and the availability of cheap machine-made cloth from England, India became increasingly dependent on Great Britain for its textiles. Before World War I India imported as much as 60 per cent of the cotton cloth consumed. Of the remainder about half was produced in domestic factories and the rest was hand-woven in the homes.

Localization of the early factory industry. The manufacture of cotton textiles in factories was India's first modern industry. Its origin dates from the latter part of the nineteenth century. The first center of development in the Bombay District was a response to a number of factors. This was the center of India's cotton producing area, and it was thus raw material oriented. However, other factors were equally important. The machinery was imported from England, so that a coastal city was desired. The Bombay area had developed one of the best systems of transportation to the interior, and marketing of finished goods was thereby facilitated. This city also had available a large supply of labor. In the early period of development there was the growth of a considerable export market, particularly to Japan and China, and a coastal location was again desirable. Bombay was also a banking center, with capital available for the establishment of a factory system. Finally the humid climate of the area gave it a preference over many of the drier regions of India.

Decentralization of the industry. At about the turn of the twentieth century the Chinese and Japanese textile import markets declined with the development of their domestic industry, and the supremacy of Bombay in the Far Eastern textile trade began to decrease. With exports diminishing in importance, the

domestic market expanded. As a result new centers of cotton textile production developed that were market oriented. The decentralization of the cotton textile industry was encouraged by a number of considerations. The Swadeshi movement in the early years of the century against the buying of British cloth aided the establishment of higher quality textiles, which had previously been imported. At the same time the movement created demands for domestic textiles throughout the country. The earlier established industry in Bombay suffered from higher wages and costs natural to a large city. The city had the disadvantage of not being centrally located, and the textiles frequently had a long and expensive rail haul to their market area. Because Bombay had no local source of power, the textile industry in a few instances grew at low-cost power sites such as the coal area of Damodar and the hydroelectric power site at Amritsar.

Major centers of present-day production in India include Ahmadabad, Baroda, Surat, Cawnpore, Sholapur, Ujjain, Indore, Nagpur, Delhi, and Poona. In the province of Madras the industry has expanded rapidly since the 1930's, when hydroelectric power became available. Important centers include Pondicherry, Coimbatore, and Madura.

The Bombay region still possesses about half of India's textile production. Although total output is slowly declining the area now specializes in the production of the higher quality goods. This is characteristic of many older industrial regions such as Ahmadabad and Cawnpore. A number of the newer areas have also developed specialty fabrics. Madras concentrates on spinning light cotton, rayon mixed fabrics come from the Punjab, and Cawnpore is noted for tent canvas and rugs.

Recent trends. There has been considerable fluctuation of cotton textile production in India during recent years. In World War II the Indian cotton textile industry, freed from Japanese competition, grew rapidly despite a shortage of machinery. Annual cotton consumption between 1940 and 1945 was 40 per cent greater than from 1938 to 1939, and exports of cotton goods rose from 177 million square yards in 1940 to 819 million in 1945. At the same time imports declined from 647 million square yards to three million.

Immediately after World War II the output of cotton goods declined, partly because of obsolescence of equipment and partly because of difficulties in replacing machinery. Cotton cloth once again became an important import item. Since 1950 production has been at about the level of the pre-World War II period. At times there has been a shortage of raw cotton. With independence, India became an importer of raw cotton, and now relies on Pakistan for a large percentage of its supply. India's domestic cotton supply is insufficient in quantity and of a short staple variety suitable only for coarse spinning. Some of the older mills in India have been closed and labor disturbances have reduced total production. India now possesses about 460 cotton mills, 12,800,000 spindles, 200,000 looms and nearly one million workers. In addition, about 1,500,000 hand looms are still in use in India, producing cotton cloth.

JAPAN

Prior to the 1850's Japan's textile industry depended upon primitive hand looms operated in thousands of Japanese homes. With a growing industrial population there was an increasing demand for cheap cotton cloth. This was first satisfied by importing textiles, principally from England. However, the demand for cloth was high and the first modern textile mill was built in 1867 at Kagoshima, Kyushu.

Development of the industry. There was a steady expansion of the textile industry after 1867. In the beginning British and American machinery, as well as technical assistance, was imported. It was not long, however, until the Japanese were adapting the foreign machines to their particular needs. In this connection spinning machinery was developed to process the cheap, short-staple Indian cotton for which there was little demand elsewhere. Most of this cotton was used to produce low-grade textiles, but there also developed the technique of mixing the expensive long-staple Egyptian cotton to make stronger, finer yarns. However, the major portion of the better-grade fabrics was made from medium-staple cotton imported in large quantities from the United States, and

later Brazil, where most of it was grown by Japanese colonists (11).

By the late 1880's the spinning and weaving of cotton had become the nation's leader in number of persons employed in factories. During the early period imports of cotton yarn continued to increase until a peak of 63,252,000 pounds was reached in 1888. From this date imports of yarn decreased until in 1911 only 737,200 pounds of yarn were imported. In the first 25 years of the Japanese cotton textile industry, it produced entirely for the domestic market. After the Sino-Japanese War of 1894-95, and with the subsequent opening of the Chinese market, the Japanese cotton textile industry began its export activities. Between 1895 and 1911 the export of yarn increased from 4,710,000 pounds to 114,003,000 pounds. The number of spindles in Japan increased from 5,450 in 1868-70 to 1,246,000 in 1902 and 2,170,000 in 1914.

Localization of the industry. The geographic pattern of the industry was established during its period of early development and has undergone no major changes. A number of factors have influenced its localization. Japan produces no cotton in commercial quantities so that all of the raw material for the textile industry must be imported. Raw cotton enters the country largely through ports in southern Japan. This break-of-bulk in transportation has provided an incentive for the establishment of the textile spinning industry in the port cities. These large port cities are also machinery centers for the production of textile machinery. The cotton textile industry is geographically concentrated, and its major areas are: at the eastern end of the Inland Sea, with the center at Osaka; on the Mino-Owari Plain, with Nagoya as the node of concentration; on the Kwanto Plain, with Tokyo and Yokohama as centers; and in the smaller cities on the northern shore of the Inland Sea.

The spinning mills are controlled by huge corporations and number fewer than 300. After the yarn is prepared it is sent to the weaving mills. The cotton weaving mills are more widely distributed, and number more than 30,000. Many of these weaving mills are quite small, having ten looms or fewer. The greatest concentrations of weaving mills are found in the same areas as the spinning mills, but many of the plants are also in small cities and satellite towns of the great metropolitan centers.

World markets. Japanese cotton textiles did not become an important competitor on the world market until after World War I. However, after 1920, export of cotton fabrics increased rapidly, and by 1933 the country had assumed first place in international trade, with an export of 2,090,000,000 square yards of fabrics. This exceeded for the first time the 2,030,000,000 square yards exported by the United Kingdom. Japan's rise to a dominant position in world textile trade developed during the 1920's and 1930's because of a unique production complex based on an advanced technology and a modern commercial organization, plus a paternalistic and uniquely Japanese system of training and controlling an ample labor supply.

The Japanese developed the cotton textile industry using apprentice and contract labor to a great degree. This system is widely used throughout the world, but had special developments in the Japanese textile industry. In the early period of the industry many farmers, with more children than they could support, would send one or more of them to a relative, who operated a shop or a one-family factory in the city, "to work for their rice." These children were unpaid, except for their essential needs.

With the development of the factory system, labor—mostly girls—was recruited by the large establishments under a time-contract system. These contracts called for the payment of a fixed fee to the girl's debt-ridden father, certain small amounts to the girl as spending money in addition to her food, clothes, and lodging, and a bonus to each girl who completed her contractual time. This was to be her dowry. Living conditions were frequently horrible for the girls in the large factories. In 1915 young girls under contract for three years worked from 4:30 A.M. to 7 P.M. and received no pay the first year. After this they were paid $1.50 to $2.00 per month, out of which they had to repay the advance given their fathers. Since the interest was compounded and the rate prohibitive in most cases, this meant slavery for life.

Beginning about 1920 social pressures, followed by government legislation, began to

improve the living conditions of girls working in the textile mills. Although by 1935 the average wage was 20 cents a day—only about one-half to one-sixth of that paid women in other industries—living conditions had been improved. The dormitories in the best mills were as good as those in Japanese private schools. By the end of the 1930's the nearly 700,000 girls employed in the cotton mills worked under conditions vastly better than those in their own homes. The girls were eager to work and the mills gained the reputation of social benefactors. The contractural labor system provided skilled workers at a cost below all other major producing nations.

In the 1930's the total labor cost of gray (unbleached) goods averaged about 1/27 of one cent per square yard. However, the direct labor cost in cotton cloth had declined in all textile producing countries until it was a minor factor in total cost. During hearings in the U.S. Congress on proposals to raise the tariff rate on Japanese cotton goods, the labor cost per square yard of gray goods was revealed to be only 1/13 of a cent in the United States. Hence the labor cost differential in favor of Japanese goods was only approximately 1/26 of a cent per square yard. Yet the Japanese were able to import cotton, process it, and ship the cotton goods to the United States at 4/5 of a cent per square yard less than the rate at which American factories could produce comparable material. The reasons for Japan's economic advantage during the 1930's must be sought in other factors besides low-cost labor.

One of the greatest advantages appears to have been Japanese technical superiority. The Japanese developed the Toyoda loom, which increased the output per worker by about five times. The loom was developed in secret, but introduced rapidly into the Japanese textile factories in the early 1930's. Another advantage was the constantly low cost of mill operation, achieved in part by low interest rates and building costs. The low cost of shipbuilding and ship insurance made it possible to reduce transportation costs to a minimum. These benefits represented a coordinated effort by the Japanese to gain a favorable world trade position.

Between 1930 and 1937, Japan's export of goods increased enormously, from 1,571,825,000 square yards to 2,644,027,000 square yards. In the latter year Japan's textile exports exceeded England's by 600 million square yards. In the 1930's about 60 per cent of all cotton goods produced was exported. The number of spindles in Japan increased from 7,045,000 to 12,296,000 from 1930 to 1937.

Repercussions of Japan's rise to dominance in the world textile market were felt by all exporting nations. However, the United Kingdom was most directly influenced, since Japanese goods found their greatest sales in India and the British and Dutch East Indies. Quota restrictions were placed on Japanese print goods in India. In turn, Japan retaliated by decreasing the purchase of India's short-staple cotton. Japan maintained world leadership in textile exports until World War II.

Cotton textile industry during World War II. Japan's cotton textile industry during World War II experienced a drastic decline. Since the traditional sources were eliminated, cotton for the textile factories was immediately in short supply. After December 1941 the export of cotton goods was entirely suspended, and most of the cotton factories were converted to munition plants or transferred to the Japanese-occupied areas of South Asia. Much of the textile machinery remaining in Japan was used as scrap in the production of military equipment. At the end of the war Japan had fewer than two million spindles, a decline of more than ten million. The number of spinning companies had decreased from 74 in 1937 to ten, either through wartime mergers or from the rigors of wartime regimentation.

Recent trends. The Japanese cotton textile industry was one of the first industries to be redeveloped. Initially, spinning was confined to the ten large firms that had survived the war. The occupation authorities granted permission to rehabilitate the industry, with an immediate goal of four million spindles. Twenty-five new companies were organized in 1947-48 to produce yarn, and after 1950, when restrictions were largely removed, numerous small-scale operations began production. All controls were abolished in 1951. Between 1950 and 1958 the number of cotton spindles increased from 3,740,000 to nine million.

A noteworthy feature of the world's cotton

textile industry in the postwar period has been the decline in international trade. Although Japan's exports of cotton fabrics increased from 422 million square yards in 1948 to 1,278,000,000 square yards in 1954, this was only half the export of the mid-1930's period. In the 1930's, although there was a general shrinkage of cotton textile trade in the world as a whole, Japan had succeeded in enlarging her exports, largely at the expense of the United Kingdom. After the war the decrease in world textile trade continued and Japan was among the chief sufferers. By the middle 1950's the initial postwar shortage of raw materials and equipment had been overcome, and the size of the industry was being set by the general decline in foreign demands. Japan no longer had access to the markets of mainland China, and her export of cotton goods to India had declined greatly from the successful competition of Indian textiles.

Although the export of cotton textiles declined, the Japanese domestic market increased. This was largely due to an increase in population. The expansion of synthetic fibers, particularly rayon, has caused a slowdown in the use of cotton textiles. Although the pre-World War II structure of the industry has been partially restored, a number of significant changes are apparent. Output of yarn has declined, but there are more spinning mills than in 1935. This increase represents the emergence of many small firms during the immediate postwar period. Just after the war, these small firms had a relatively large share of production, but in the 1952 textile depression they declined in importance. In recent years the "big ten" had over three-fifths of the total spindles and nearly two-thirds of the looms owned by the integrated concerns. In the spinning-weaving branch of the industry the high concentration of output in the hands of a few firms has remained unchanged (24).

Possibly the greatest change in the industry's structure has affected the specialist weavers. This group has increased its share of the nation's output, primarily because of the export market decline and the subsequent growth of the domestic market. In the 1930's the export market was dominated by demands for standardized articles. These goods were usually supplied by the large weaving firms. The recent Japanese market has demanded a wider variety of cotton textiles, and the specialized weavers have been more successful in supplying the needs. The rise in relative importance of the specialist weavers is likely to continue. Another important trend involving the specialists has been the combining of cotton with synthetic yarns. These varieties form a much higher proportion of the specialists' output than of the integrated firms' output. This is another reason for the recent success of specialist weavers.

SOVIET UNION

The cotton textile industry is one of the oldest of Russia's factory industries. During the tsarist period it developed on a basis of available labor, foreign capital, and a technology largely imported from Western Europe.

Localization and development during the tsarist period. The Russian cotton textile industry had its origin in the middle of the eighteenth century. The first plant was a calico-printing factory for the processing of imported coarse cloth with fast dyes. This factory was built in the village of Ivanovo in Vladimir Province (now Ivanovo-Voznesensk). From this center the processing industry spread to adjoining districts in the Vladimir and Moscow provinces.

Cotton weaving also began in the middle of the eighteenth century. It was originally based on the importation of English cotton yarn. During the late eighteenth and early nineteenth centuries cotton spinning based on imported raw materials appeared. The first cotton spinning factory was erected at Schlusselburg (Petrokrepost) in 1793 with foreign capital. By 1812 Moscow had 11 cotton spinning mills with a total of 780 spinning machines.

During the nineteenth century a number of factors encouraged the growth of the textile industry. During the entire tsarist period there was an expanding domestic market for cotton goods. Although the buying power of the Russian peasant was low, and the consumption per capita not particularly high, the large population provided a considerable market. At the same time cotton cloth was cheaper than linen or woolen goods and these served a

preferred market position. However, during the nineteenth century production gradually exceeded domestic demands and foreign markets were sought, particularly in the Middle and Far East.

The Russian cotton textile industry was given an additional boost with the abolition of existing bans against the export of cotton textile machinery from England by the Act of 1842. From that period the Russians utilized not only English yarns, but also the most modern English machines, and true factory production began. The successful incorporation of English technology into the Russian cotton industry continued throughout the nineteenth century and until the Revolution of 1917. With the development of a domestic cotton industry, Russia began to produce its own cotton in the 1850's. By the beginning of the twentieth century Russia was producing about 55 per cent of its cotton needs from Central Asia and the Caucasus. The remainder came largely from the United States.

From 1820 to the Revolution the cotton textile industry experienced a considerable expansion. In 1826 there were 42 mechanized cotton mills, employing 94,600 workers. In addition there were 66,200 workers in homes. By 1879 there were 92 mills, employing 162,700; but the number of home workers had declined to 50,200. The industry continued to grow, and by 1894-95 there were 242,100 workers in factories, but only 20,500 at home. In the first decade of the twentieth century Russia had six million cotton spindles. By 1913, the Russian cotton industry ranked fourth in the world, and consumed about 1,500,000 bales of cotton. Russia was producing about 15 per cent of Europe's cotton goods output.

During the tsarist period the Russian textile industry was concentrated in western Russia in the Central Industrial District. The major areas were the Moscow Oblast, with such centers as Moscow, Orekhovo-Zuyevo, Glukhovo, Pavlovski Posad, and Serpukhov; Ivanovo Oblast, with centers at Ivanovo, Shuya, Vichuga, Kineshma, and others; Leningrad Oblast, with centers at Leningrad and Schlusselburg; and Kalinin Oblast, with centers at Kalinin, Vyshni Volochek, and others.

This localization was because of a number of factors. The importation of cloth, yarn, and textile machinery gave the areas nearest the Baltic ports an early advantage. This was also the region where the industrial labor supply developed. At the beginning, production of rural home cotton goods provided the source of trained workers. Gradually a body of skilled workers developed around the original centers of production. Western Russia was the area most easily reached by cotton imported from foreign sources. There was also the availability of power, first from wood and later from the area's peat and coal resources. Finally, this was the region of densest population, with the highest buying power in Russia.

In the period just before the Revolution the Central Industrial District had 85 per cent of the cotton textile industry and the Leningrad area an additional 8 per cent. The only other area of major importance was the North Caucasus region, with about 5 per cent of the nation's total.

Textile industry during the communist period. After the Revolution the cotton textile industry declined for a number of years. Of about 7,200,000 spindles in the Soviet Union in 1924, only 2,700,000 were active. The redevelopment of the industry began with the institution of the first five-year plan in 1928.

Under Soviet domination a number of significant developments has occurred. The cotton textile industry has been modernized. To provide machinery, a domestic textile machinery industry was created in the 1930's. By 1939 most types of textile machinery were being produced, and imports had been all but eliminated. There has also been a movement to increase the labor efficiency. However, throughout the 1930's the cotton textile industry did not meet its production goals, partly because of a shortage of spinning facilities and partly because of inefficient labor and poor equipment.

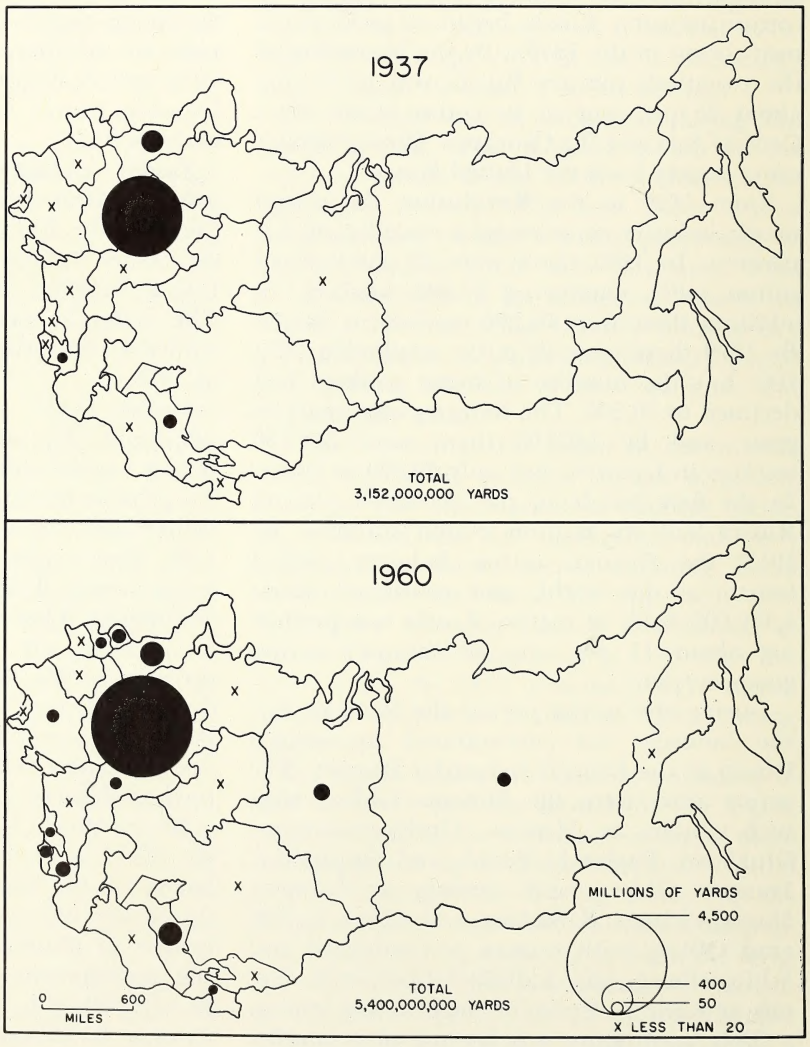
Before World War II there was a considerable effort to produce more raw cotton in the Soviet Union. This has been accomplished by increasing the acreage of cotton in the old centers of Central Asia and Azerbaijan, and the development of cotton in such new areas as the Ukraine, the North Caucasus, the Crimea, Kazakhstan, and other suitable areas.

By 1939 the Soviet Union was not only self-sufficient in cotton but had become an exporting nation.

The growth of the textile industry stopped during World War II. It is reported that during the war the Soviet Union did not utilize three million of its spindles. The output of cotton goods declined 60 per cent from 1940 to 1945, more because of a shortage of manpower and fuel than because of military destruction. In the postwar period the cotton textile industry has once again expanded. In 1948, 3,150 million meters of cotton fabrics were produced. Output in the early 1960's has been at the 5,500 million-meter level.

Although there has been some dispersal the Soviet cotton textile industry continues to be concentrated in the pre-Revolutionary areas (Map 15.6). About 80 per cent of the industry is found in the Central Industrial District. There has been some tendency for the textile industry in the Moscow-Ivanovo area to specialize in the manufacture of high-quality fabrics as well as special fabrics for such industries as chemicals and machine building. Ivanovo remains the "Manchester" of the Soviet Union, being the center for an important textile district. Leningrad continues as a prominent center of production, with about 5 per cent of the Soviet Union's cotton cloth output.

Under the government's planned industrial



15.6. Soviet Union — Cotton Fabric Production—1937 and 1960.

dispersion policy a number of new centers have developed. The cotton producing areas have been influential in the location of new mills. In Central Asia mills are now found at Tashkent, Fergana, and Ashkhabad. New cotton factories are also found in Transcaucasia, in Azerbaijan at Kirovabad, and in Armenia at Leninakan. A number of textile mills have also developed in new industrial centers such as Western Siberia at Barnaul. Nevertheless, the new centers produce only about 10 per cent of the Soviet Union's cotton textiles. The same factors of markets, power, transportation, and labor which originally localized the cotton textile industry in the Central Industrial District persist to the present.

GERMANY

The cotton textile industry has been a major one in the German economy since 1870. Nevertheless, the heritage of the early industry has been an important influence in the localization of the modern manufacturing pattern. The cotton textile industry first appeared in Germany in the middle of the eighteenth century, when imported cotton provided the basis for a small industry. Development was most important in areas which possessed excess population and low economic development. Initially, small factories were built in isolated mountain areas, but these factories rapidly localized at the foot of mountains, on valley routes leading to the plains. Thus, water power and transportation routes were important factors in locating the early textile factories. Later, coal played an important role in providing power for the textile industry, and influenced its location.

Localization of the industry. The textile industry is widely distributed in Germany, but the greatest concentrations are in the major industrial areas. Of these, the Rhine-Westphalian area is of outstanding importance (10). Here the cotton textile industry is integrated into the area's total industrial structure. Ruhr coal has been the greatest localizing factor, not only in making power available for the factories, but also—through the process of coking the coal for the metallurgical industries—providing the coal by-products that are the basic raw materials for the production of analine dyes. Until World War I the Ruhr region held first place in world dye production. Through a similar relationship, the heavy and light industries have played a complementary role in that men are employed in the heavy industries while women are textile workers.

Within the Rhine-Westphalian area the small cotton mills are widely dispersed. However, the greatest concentrations are found in the central valley of the Wüpper in such cities as Wüppertal-Elberfeld and Barmen. This concentration results from a number of factors. An early textile industry evolved in the valley because of available water power, and a few factories are still operated here by hydroelectric power. The textile industry also requires pure water in considerable quantity for dyeing and processing the cloth. Because of the great water needs of the iron and steel industry, located along other streams in the Ruhr area, the Wüpper River provided the only remaining large source of water not used by these other industries.

In eastern Germany the textile industry finds its greatest concentration in the rugged areas of the Sudetes, the Riesen Gebirge, the Thuringer Wald, and the Harz Gebirge. The industry in these regions evolved from earlier woolen and linen activity. Water power originally played a role in localizing the factories. In more recent times fuel has been supplied to the area from the lignite deposits of the German plains to the north. In the nineteenth century this area was a major mineral producing region; but with the gradual depletion of the mineral deposits, the textile industry grew in importance. Today the textile industry is strongly concentrated in the old metalliferous centers. The availability of a labor supply appears to be a factor in the present localization.

Since World War II this area lies in East Germany, where a planned economy exists. However, the economic structure of the industry and its localization have been little affected by the government's direction. Most significant have been the changed commercial relations. Divided from the West, East Germany must get her raw cotton from the Soviet Union, and trade in finished cotton goods is directed primarily to Eastern Europe.

Besides the major regional concentrations,

the cotton textile industry is well established in a number of other centers. Many of the important industrial cities such as Hamburg, Frankfurt, Munich, Kassel, Stuttgart, and Bremen have well-developed textile industries. These works are localized by available labor, and the development of the apparel industry has provided a market directly in the cities. Finally, the industry is widely diffused throughout the country. Many small textile establishments are in the valleys of the Black Forest, the Upper Neckar Basin, the Central Rhine region, Hesse, and the High Palatinate. In these areas many of the factories have long been established, but most have been modernized and are efficient plants. The attraction of a body of labor for the employment of which there is no competition from other industries is usually the major force localizing these cotton textile factories.

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PERSPECTIVE

Modern industrialization began in Great Britain about two centuries ago. This was the first nation to alter the traditional dependence on agriculture and commerce as the basic occupations. By about 1830 Britain had attained an industrial status, and industrial societies were developing in other nations. In the nineteenth century, and up until World War I, industrial economies had developed in most of the northwestern European countries, the United States, and Japan. In the interwar years the Soviet Union instituted a rapid program of industrialization and by 1940 had joined the industrial elite.

Since World War II there has been a deliberate fostering of industrial growth in the world. Most of the agricultural nations of Asia, Africa, and Latin America have established ambitious industrialization programs. In those nations which possess underdeveloped portions, such as southern Italy, programs have been developed to reduce the internal industrial differences. There is a sense of urgency motivating these nations, a belief that they must industrialize or face future economic oblivion.

The present world-wide trend to create an industrialized society springs from a variety of causes. Possibly the most pressing incentive to industrialize has been brought about by the rapid growth of population, particularly in the underdeveloped countries. How to cope with these increasing numbers—which threaten to lower living standards—is of major consequence. In the agrarian nations where high population densities exist, the problem of finding new employment opportunities is most acute. In the present era the solution most often proposed to find productive employment for the growing labor force is that of planned industrialization. The evidence is strong from the past experience of industrially advanced nations that the industrialization process is a principal means of raising living standards.

In the development of the industrial societies of the world, a number of models are now

available from which a country may choose to implement its new industrial order. Kerr indicates five types of groups that assume leadership in the industrialization process.[1] Industrialization is always introduced by a minority group. In England in the nineteenth century the middle class capitalists provided the initial incentive to industrialize. These men are usually noted for their pragmatic approach to the establishment of the new order. They normally favor a structure of economic and political rule which permits them to operate effectively. Self-advantage is frequently a motivating influence. In Germany and Japan, dynastic groups, drawn from the landed and commercial aristocracy, were instrumental in establishing an industrial society. These groups normally place emphasis on family and class ties. Although the industrialization process inherently involves change, the dynastic group has respect for the preservation of certain aspects of tradition. Industrialization has also been introduced into certain regions by colonial regimes. Examples of this are found in India and certain countries of Africa.

In recent decades two new methods of introducing an industrial economy have become prominent. Revolutionary intellectuals were the instruments for the establishment of modern manufacturing in Russia and communist China. This group has as its goal the complete destruction of the existing society. They contend that the only means to progress is through the centralized state. "The world conflict is seen in large part as a test of which system can make the best use of the new technology. This means forced-draft industrialization and the construction of a culture which is consistent with the new technology and its fullest utilization." The implementation of industrialization by nationalist leaders has grown in importance in recent years. Many of the present-day industrialization plans of Africa and Latin America have been conceived by nationalist leaders. Because nationalism assumes many forms, industrialism may take a number of routes in its development. Nationalism is a viewpoint, not a political ideology.

Once a system of industrial implementation has been established, the science and technology necessary to create an industrial economy become available to all nations. Ideas and techniques know no national boundaries, and are readily transplanted from one country to another. The diffusion of ideas from centers of advanced technology can occur in a number of ways. Traditionally, ideas have been spread through the private enterprise system. In recent years other methods of dissemination have been added. Governmental entrepreneurial activities constitute a growing means of introducing the technical concepts of industrialization. Technological and scientific concepts are also obtained by a nation through the training of its students in industrially advanced nations and through the importation of foreign experts.

Once industrialization has obtained a foothold in a country, its most obvious manifestation is the rise of the industrial city. The most heavily industrialized areas are also the most densely urbanized. The industrial city originally appeared in northwestern Europe and the United States, and the new industrial cities are closely patterned after the prototypes. The movement of great masses of people to the cities represents primarily a response to greater employment opportunities and the hope for a better standard of living. The rapid growth of population in the cities, however, has created many problems. Much has been written about the deplorable living conditions in the industrial cities of nineteenth-century England and northwestern Europe. The newly developing industrial cities of Asia, Africa, and Latin America are patterned after those in the older industrial nations, and they are now experiencing many of the same problems. Motwani has aptly described the new industrial cities of South Asia:

> . . . huge mausoleums of coal, smoke, iron and steel, of dirt and squalor, of overcrowding, of cooly-lines, and human warehouses. Long hours, low wages, bad housing, women and child labor, infant mortality, accidents, high rents, poor sanitation, prostitution, gambling, racing, dope dealing, dance halls, cabarets and night clubs were features of all the

[1] Clark Kerr *et al., Industrialism and Industrial Man: The Problem of Labor and Management in Economic Growth* (Cambridge, Mass.: Harvard University Press, 1960).

cities. The noise corroded the nerves of the city dwellers, while absence of neighborhood restricted their social contacts and made them strangers to each other.[2]

In spite of their problems, the industrial cities are continuing to grow in the underdeveloped countries. Industry is gradually creating a "city" consciousness. As a consequence a social structure is evolving bringing with it new types of social behavior and economic awareness. The industrial society which began about 200 years ago in Britain is now spreading to the world's underdeveloped countries. Although the world is now approaching the threshold of a global industrial society, its final implementation will depend on the rate at which the underdeveloped nations are capable of accepting certain scientific, technological, organizational, and psychological changes in their traditional way of life.

[2] Kewal Motwani, "The Impact of Modern Technology on the Social Structure of South Asia," *International Social Science Bulletin* (Winter 1951), p. 787.

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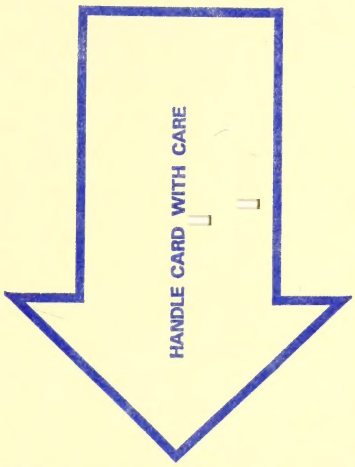
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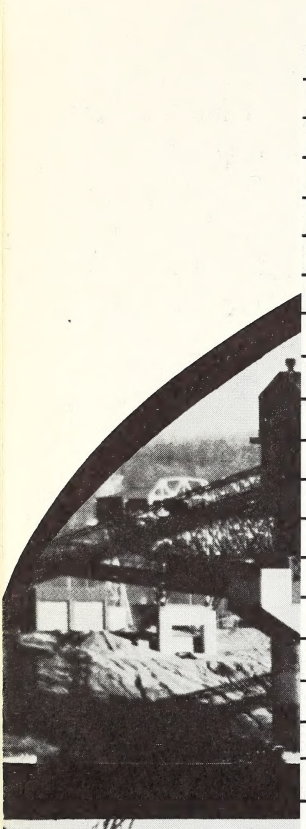
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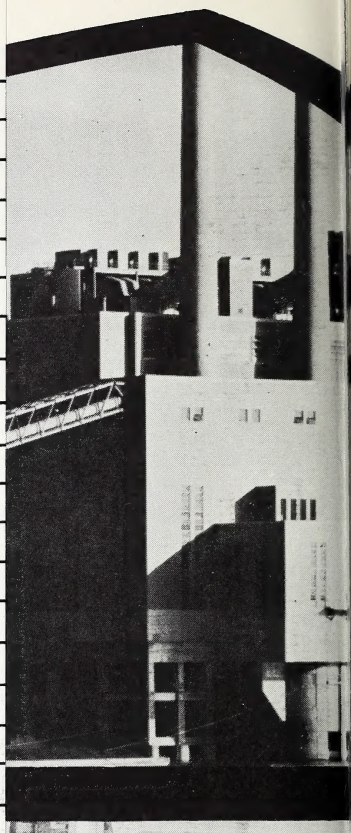
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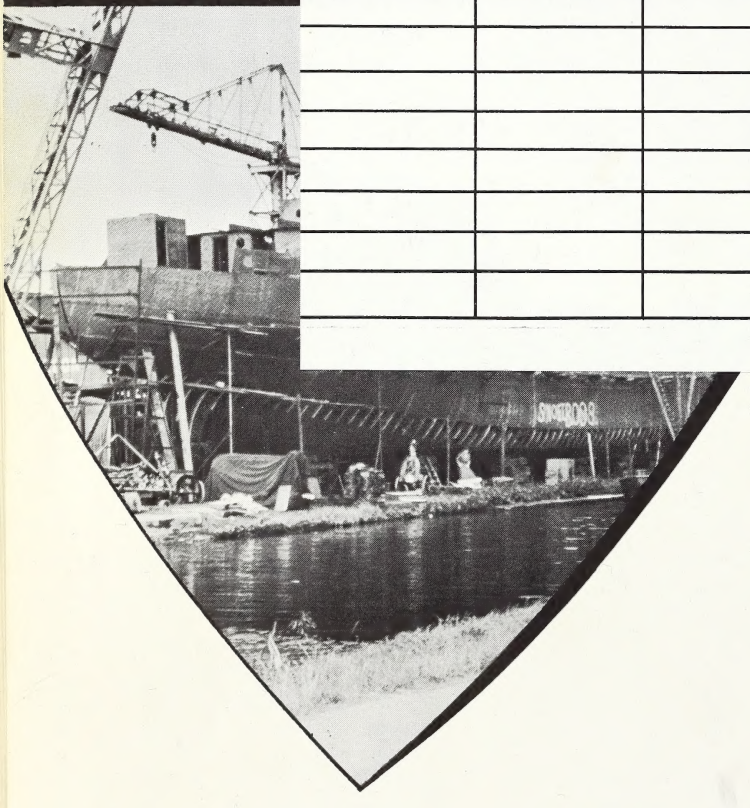
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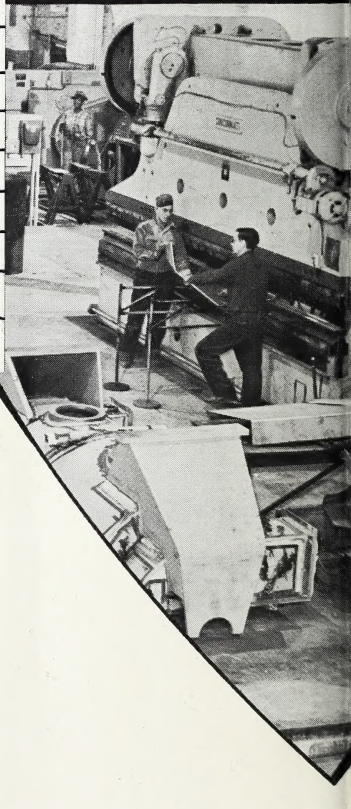
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